Sarah Zaleski: Hello, and welcome to the 2020/2021 Better Buildings Webinar Series. In this series we are profiling the best practices of Better Buildings partners and other organizations working to improve energy efficiency in buildings. I'm your moderator, Sara Zaleski. I serve as the Department of Energy's Senior Advisor in the Building Technologies Office where I lead commercial building integration, zero energy efforts, multibuilding solutions, and our portfolio of various other projects. In previous roles at DOE I also led local government clean energy innovation programs.

I want to thank you all for being with us today. We have a really wonderful session planned with some fantastic speakers who I'll introduce in just a moment. So we're excited to announce that today we're going to be using an interactive platform called Slido for our question and answer portions, so if you can please take a moment to open up in your web browser and go to this website, www.slido.com. You can use your mobile device if that's easier.

Today's event code – you'll be prompted – is just #DOE. You can enter that. I think it's on the left side of the screen. And if you'd like to ask our panelists any of the questions please submit them any time throughout the presentation and we'll keep an eye on that screen and follow up with them at the end. If you can select a thumbs up if you see questions that you like we'll take that into consideration too, so if we see that there's a lot of people interested in a certain question we'll try to give that more attention. So, thanks folks for taking a moment to do that.

So we're going to start things off with a couple quick polls in Slido so we can learn more about you, our audience. So if you can please join us on that platform of Slido and respond to the next two polls that would be great. Marissa, when you're ready if you could show us what we're asking about here. So the first question we'd love to hear from you all is obviously the theme of today's presentation is carbon reduction in multibuilding projects, and assuming that that's of interest to your organizations we're interested in what your drivers for your organization carbon reduction are. Some of the options here, environmental stewardship, cost savings, corporate citizenship, existing or predicted regulation, customer demand, employee satisfaction or supply chain requirements.

So we'll give just a minute for folks to respond to that, and you can see some of the live polling results here. Thank you for sharing those, Marissa. We'll wait till we get to the triple digits for respondents. All right, so environmental stewardship and cost savings seem to be up towards the top of the list there. Please feel

free to respond to that for another couple seconds. All right. So it looks like, yep, environmental stewardship and cost savings were at the top.

We'll ask one more question. So what aspect of carbon reduction, particularly in a multibuilding project setting where we're not just talking about one building but a whole campus or a collection of buildings, what do you think might be the most challenging aspect of that? Some options would be measuring and verifying technical opportunities, getting buy-in from multiple parties and that coordination, figuring out how to pay for it, identifying technologies or others. I believe our speakers today are going to touch on all of these aspects to one extent or another, so this will help us kind of guide too any sort of emphasis and questions.

So not surprising, financing and how to pay for it is near the top of the list, and then getting buy-in from multiple parties. Certainly I think and you'll hear that when you look at the multibuilding scale it opens up additional opportunities but not without some complexities too in terms of coordination and business arrangements across multiple parties, so I think we'll hear a bit about that today as well. All right. So thanks, folks. We'll go over to our agenda now, and thank you for those that participated in the polls.

Today we're going to be talking about big projects which are making big carbon reductions. Most of us on the webinar today, like we spend a lot of time thinking about ways to reduce energy use and associated emissions in our buildings, and today we're going to take that up a notch and look outside the box of just our buildings and explore ways to achieve even greater impact by leveraging opportunities for multibuilding scale. So for instance, opportunities balancing loads across building so that you can shave peak demand when you average those out or achieving economies of scale in procuring professional services or technologies, capturing waste energy to heat campuses and integrating distributed energy resources such as solar and storage at a bigger scale in a way that might not be feasible at a building-by-building scale.

So we're going to hear first from two specific projects. We're going to hear from the Catalyst Project and Mackenzie – excuse me – a couple of folks from McKinstry. They're going to talk about the Catalyst Project in Spokane, Washington. And then we're going to hear about the National Western Center Project in Denver, Colorado. We'll hear about those two specific and very exciting

and innovative projects first and then we're going to hear from the National Renewable Energy Laboratory with a bit of a birds eye view on trends and resources across this space nationally.

So we're going to try to save a little bit of time for a question or two after each of the presentations and then reserve some more time at the end for Q&A as a panel. So without further ado I'm going to introduce our wonderful lineup of presenters. First we're going to hear, like I said, from the Catalyst Project. Brad Liljequist is a climate solutions pioneer and thought leader who runs McKinstry's Zero Energy and Carbon Program. He's worked on in addition to Catalyst 17 other zero energy, carbon, living, building and passive house projects that are underway at McKinstry.

Prior to McKinstry, Brad directed the Energy Carbon and Communities Program at the International Living Futures Institute where he created the first worldwide zero carbon standard. He also directed development of zHome, the first ILFI certified zero energy community in the United States and is the author of *The Power of Zero*, which showcases 19 certified zero energy buildings. Brad continues to be on the forefront of climate solution innovations, most recently leading the feasibility of one of the world's largest zero heat recovery projects now in development. Joining Brad will be Nick Edney. Nick is a senior electrical engineer at McKinstry.

He is passionate about applying sustainable practices to the engineering and commercial realities of our built environment. Nick combines his understanding of inbuilding energy consumption and knowledge with the broader utility system to identify opportunities for big picture system efficiencies. Nick is an integral member of the team, delivering the Spokane Eco-District, which aims to demonstrate value creation in the space towards electrification of buildings and transportation. So next we're going to hear from the National Western Project Center – or excuse me, the National Western Center Project. First up from those folks is going to be Barb Frommell who is the strategic partnerships director for the Denver mayor's office for the National Western Center.

In that role, Barb manages external relationships to foster positive, long-lasting, and mutual beneficial partnerships in support of the National Western Center. Barb is the collaborative problem-solver with nearly 20 years of development experience across communications – excuse me – across government, private and nonprofit sectors. Her career is focused on strategic planning and

communications, partnership development, relationship management, special projects management and innovative funding and financing strategies to build more sustainable, resilient communities. Joining Barb will be Laura Rip.

Laura is the campus energy project director for the National Western Center, which is working with energy partner EAS to implement a first-of-its kind wastewater heat recovery system, which will both heat and cool the campus buildings. She works with the local utility company, Excel Energy, on campus-wide renewable and resiliency energy options to best manage the campus's unique stock show loads. She is a mechanical engineer who quickly honed especially energy efficiency when she started her career at NREL's Wind Technology Center. The past eight years she's worked for Jacobs in all facets of building energy consulting and it's taken her from all sorts of different environmental extremes, from the tropics of Guam to the deserts of California and the ice sheets of Greenland.

And then last but certainly not least we'll be hearing from some of my colleagues at the National Renewable Energy Laboratory. First up will be Shanti Pless. Shanti joined the Commercial Buildings Research Group at NREL in 1999 with a focus on applied research and design processes for commercial building efficiency and integrated renewable energy. His recent work has focused on district scale energy planning and optimization to explore additional energy opportunities beyond one building at a time approaches. And then lastly we'll be joined by Ben Polly who specializes in the development, validation, application of energy analysis's approaches for individual buildings and collections of buildings at NREL.

He has developed and applied software testing approaches for residential, audit tools, and associated utility bill calibration methods, methods for calculating lifecycle cost optimal retrofit packages and approaches for analyzing measured energy consumption to improve software prediction accuracy. So, lots of experience represented here. Really excited to hear from these six great speakers. So as a reminder before we get started, please send in your questions using Slido.

Again, the event code is #DOE, and we'll get to as many as we can. We are also going to archive this session and post it to the Better Buildings Solution Center for your reference. So at this point, without further ado, I'd like to pass it over to Brad and Nick to discuss the Catalyst Project. You both ready?

Brad Liljequist: Yeah.

Sarah Zaleski: All right.

Brad Liljequist: Great.

Sarah Zaleski: Take it away.

Brad Liljequist: Thanks so much, Sarah. We're really pleased to be here. If we could go to the first slide that would be great. Thanks so much, everybody. We're just thrilled to be here and really excited to share our very exciting Catalyst and South Landing projects actually, and when I was looking at the intro slide I realized we should've said both. But just by way of a quick kickoff, we are actually going to be talking about two projects in one.

So South Landing is actually a brand new district that McKinstry has designed and developed and will be the owner of in Spokane, and Catalyst is a building within the South Landing District. It was the first building built. South Landing includes an all-electric, very pioneering, next generation, all-electric energy plant that will provide heating and cooling to the whole district. That's really going to be a lot of what we talk about today, and Nick is going to dive into that. And then we'll just talk a little bit about the Catalyst Project, which is the building you see in front of you here.

We're registered as pursuing zero energy and zero carbon certification with the Living Future Institute, a very pioneering kind of exciting evolution of scale I would say in zero energy and zero carbon. Nick and I both work for McKinstry, so McKinstry is a design, build, operate, maintain company. We're headquartered in Seattle. We are a national company, however. We have about 25 offices around the US, couple thousand employees, we do bumping up against about $1 billion a year in revenue, and we really cover the gamut of kind of the mechanical, electrical and plumbing space, all the way from a design group that Nick and I work for, an engineering design group of about 100 engineers and designers, but then we also do construction of MEP systems.

What's unusual for us frankly about South Landing is this is kind of a new step for us where McKinstry is actually acting as the developer through our Emerald Initiative affiliate. So really the purpose of us doing this we really reached a point and it was really our senior leadership led by Dean Allen our CEO, really felt like it was time to just start building the change that we feel like we

really need to see to address the climate crisis. Next slide. I'll get everybody oriented. South Landing is located, as Sarah was mentioning, in Spokane, Washington, a medium-sized great city in Eastern Washington.

Spokane, east of downtown, if you've ever been there or if you haven't it has a fantastic university district actually where six institutions of higher education are collocated – Gonzaga's main campus is there and then five satellite campuses are there as well. Next slide. I'll just highlight – this is highlighting where the South Landing campus is. Essentially what we're doing is expanding the South Landing District. South Landing is pretty – I'm sorry, expanding the university district of Spokane.

There's a set of rail tracks to the south of the university district and we're building to the south. If you could go to the next slide that would be great. So this is the South Landing site. South Landing is – you can see here in the foreground there are two buildings built at this point. There's the Catalyst building – next slide – which again is now actually occupied, and then another building that's also occupied, which is the Morris Center, which is that silver-blue building, and that building – if you could go to the next slide – that shows – our district energy plant is located in that building.

These two buildings in the foreground, those are conceptual. Those are not built at this point but they are under planning, and then there's actually another development site just to the right of Catalyst. Next slide. Catalyst itself, like all great efforts, is a partnership, so that partnership has been led by McKinstry and Emerald Initiative but has had some very heavy involvement by other players, Avista Utilities and Development. Avista is the local utility that serves Spokane and the surrounding area.

Avista has been really a very kind of eminent partner in the process of building the project. They actually own the land and they are a development partner in the Catalyst building. They are also very critically involved in the grid integration of the energy district power plant – or heating and cooling plant – which Nick will go into a little bit more detail on in terms of how we're integrating it with the grid. Katerra is also a development partner or a project partner on Catalyst.

They actually were the general contractor. Some of you may know Katerra. They are a cross-laminated timber builder, so that really helped us achieve our embodied carbon goals. And then finally, Eastern Washington University is actually going to be the main

tenant. They are the main tenant of Catalyst. They are now occupying it. Obviously we're in COVID times right now so they're kind of slowly moving their functions in there, but they're going to be – they are occupying most of the building – next slide – which is great.

It's their STEM program and it just really fits with what we're trying to do. We are going to do now a quick flyover, drone flyover of the site. If we could go ahead and start, and I want to mention that it is going to tell you that the sound is muted or – don't worry about – there's not supposed to be sound. I'm going to do a voiceover so you'll get a little readout here though. Okay, here we go. So that is Catalyst.

That's a development pad there on the right. That is the Morris Center. You can see actually the district plant, heating and cooling plant, down in the storefront area of the Morris building, again, which is the gray-silver building. This is flying away over the existing university district across the Burlington Northern tracks and then pivoting to look at downtown. That's the ped bridge that connects – pedestrian bridge that connects the two. That's downtown Spokane and a beautiful sunset, so a very beautiful setting.

If you're ever in town it's actually kind of a nice walk from downtown. If we could go back to the deck that would be great. Okay, next slide. Great. So I'm going to shift gears a little bit and just tell you – share a little bit about the sensibility about how McKinstry approaches our thinking about the climate crisis. I really want to say McKinstry really is taking the climate crisis seriously. We talk about it as a climate crisis, our leadership talks about it as a climate crisis.

We have joined the Climate Pledge set forth by Amazon with a number of partners, and we are really very specifically aligning a lot of our business to really focus on that, and that's been a longstanding thing for McKinstry, but I would say over the last three or four years that's accelerated and this project is a reflection of that. But we also bring I think a bit of a different sensibility to that problem, one of which is that we are not going to be able to solve the climate crisis unless we solve the affordability crisis and the innovation crisis in construction. This slide is – McKenzie did a study a number of years ago and we have had basically declining productivity in the construction sector over the last 60, 70 years.

I said declining; I should say flat. But that is different than every other industry. Tech's not even on this because it basically has gone vertical in terms of productivity. Yes, we do need to put more resources into the climate crisis as it relates to the build environment, but there is gold in these hills and so we feel like by providing innovation or economies of scale, those sorts of things, that's going to help us achieve this. Next slide.

Another thing that we think about – it looks like the bottom of the slides here are cut off a little bit but I can read these to you – I think when we start to think about multibuilding approaches it's really important to think about nested and kind of comingled opportunities, one of which is these districts are a real opportunity for us to champion zero carbon solutions at scale. The Catalyst building, we are a big believer in starting to build and signify to the market what you're talking about when you talk about zero carbon, so actually building a zero energy or zero carbon building early on is a great way to do that. Sharing energy, you know, thinking really holistically about heat recovery, cooling recovery, thermal exchange as well as electrical exchange and kind of spreading out your renewables as much as possible is very important.

Utility partner is really critical and we feel like is probably of all five of these maybe the most important. I think all of us have been working very hard at zero carbon and zero energy solutions but we've been very focused on the building scale. The district scale is great, but what it starts to do is it affords us an opportunity to help work with the grid and make the grid zero carbon, because that's the end game. It's not about a bunch of disparate zero carbon buildings. Digital backbones I think are a real opportunity when it comes to energy districts.

You know, physically a lot of the times you're opening up ground, you may be boring and tunneling to provide thermal connections, electrical connections. You can also do that to have a wired community, which really adds value. And then finally, having a district scale really enables you to engage your users. Next slide. If you go to the next slide actually…I unfortunately am not going to have a ton of time or any time to talk about Catalyst, the Catalyst Project, through the lens of zero energy and carbon at all, but that last link there – and this will show up at the end of our slide deck – that Bitly link, takes you to a really nice case study that is specific to how we achieved zero energy and zero carbon on Catalyst.

Next slide. And this will be my last before I hand it over to Nick. I just want to mention that we Catalyst includes extension onsite

renewables but it also includes offsite renewables as well. So our zero energy and zero carbon generation is not just on Catalyst but it's on the adjacent Morris Center as well as other buildings. So with that I'll hand things over to Nick.

Nick Edney: Thanks, Brad. And we can move to the next slide please. Now in a moment I will dive in on some of the technical details of our plant, but before I get into those details I'd like to touch briefly on what we call the energy value chain. So within the typical commercial building framework there are three key energy participants. There's utility providing the energy and the building, which is represented by designers, builders, owners, operators, and then there's the occupants. Between the utility and the building it's the meter, and we can think of it also as a tariff or the agreement between those two parties.

This represents a historical construct that often results in suboptimal energy outcomes, and similar can be said about the leads which separates the buildings from the occupants. So as Brad mentioned, the South Landing development really is a partnership which includes the utility, the designer builder and occupants, so we aim to demonstrate the new goal that we can unlock by collaborating through these barriers. Next slide please. So, typically a cold climate – high-performance building in a cold climate would be based on inground source heat pump solution. Unfortunately, in our case we were unable to identify or use a ground source resource.

The open loop test hole that we drilled was a poor performer. A vertical bore hole was cost prohibitive because this site is located on those whole bedrock, and horizontal coupling also was eliminated due to cost and constructability challenges. So as a result of those constraints our system designs had to get a little more creative, and we ended up with a central plant that combines the strengths of various systems. Of particular note, heating and cooling systems are fossil fuel free. We have no combustion onsite, so we actually rely on electric boilers to meet winter peaking. Next slide please.

As you see the building becomes more efficient – and it's a shame Brad didn't have more time to talk through some of the really cool aspects of Catalyst – the annual need for heating and cooling is reduced through our campus, even in the winter months, so a large proportion of the heating needs are met by internal gains in heat recovery. So we have a cooling-dominated system even in a cold climate zone like Eastern Washington. To that end, the selected

chilling system has high efficiency and does the lion share of cooling. What you're seeing here on this graph is the space conditioning load served by the central plant.

Above the axis is the cooling load and below the axis the heating load. Next slide please. If I adjust the Y axis scale a little it allows me to show some more detail on the heating side, and due to the efficiency of the chilling plant, a new climate zone in winter, and the heating load of the building really does become the critical period for energy consumption and also for utility impact. So just quickly we're going to step through how we provide heating from our central plant. Firstly, we will always dispatch heat recovery, and it's the most efficient way to provide heating and cooling. Then we show thermal storage here, which typically represents heat recovery in energy that is stored rather than consumed when we don't have a need to use it instantaneously.

It can also represent stored energy from air source heat pump or electric boiler. Then we would dispatch the air-to-water heat pump and then finally our backup electric boiler. Now I'll ask you to just keep your eye on that little orange sliver down at the bottom that represents electric boiler as we move to the next slide. This next slide actually represents the amount of electric energy required to operate the equipment to meet the load, and you can see that even though that electric boiler only makes up a very small proportion of the load served it does consume a disproportionate amount of electric energy and actually becomes a significant driver behind our annual utility peak.

Next slide please. I put this slide in here not least because this is a really cool tool that we've been tracking its development and provides some awesome insight into energy markets across the nation, but it also highlights that not all utility markets are created equal or perform equally. So it's important that we system designers do the math when evaluating systems buildings but also understand the drivers within the specific grid the product is located in. In our case, we are in the Avista distribution territory within the Pacific Northwest. Next slide please. What you're seeing here is the Avista system load profile for the 2019 summer and winter peak demand days, summer being represented by the yellow and winter by the teal.

For Avista, winter is the system peak but it's also the greatest area of focus. The consequence is not permitting load in a small significant. Avista being a hydro-heavy utility fee reduced winter generation due to reduced hydro flows. A lot of precipitation falls

as snow in the winter. Avista also expects to see winter load increases at some point as they transition away from natural gas heating and produce at their winter peak. Next slide please. I'm going to step you through some of the more interesting results from our energy model, and what I've done here is actually removed all the heating and cooling from the load profile, and let's look at just the underlying electric load of the buildings themselves.

This is about 2,000 square foot of commercial office and higher education tenancy. So this heavy black line represents the steady flow of the building, lighting, plug load, ventilation, the kind of load that is really a target for efficiency and design or efficiency campaign. It can be shifted with battery electric storage, but aside from that there's not a whole lot we can do to manage it without more invasive strategies that impact occupants – think of dimming lights or shutting off load – and they tend not to be desirable for tenants. So you can think about this load profile representing what we could achieve if we had a high efficiency building but was heated with a gas boiler. Next slide please.

In our case we have an electrified heating plant. The electrification load is the biggest challenge for grid integration. This is represented here with a red curve. It's quite well corelated with the utility system peak. And the next slide. The result of some of these trends shows what is seen by the utility and shows that we are requiring approximately 450 kilowatts of additional capacity to be built out in the utility system to support this development. If we move to the next slide, our central plant has approximately 24,000 gallons of thermal storage, which was designed and then dispatched to maximize heat recovery, particularly during shoulder seasons.

We also had the opportunity to utilize this asset to mitigate utility demands. Here what I've done is simulated shifting the original load profile, which is grayed back now in the light red to show what we can do if we preheat overnight and store and dispatch that during the peak period shown with the heavy red curve. And if we move to the next slide, in this way and with the green curving some of those loads, you can see how we have the potential to deploy in-building assets for utility benefit and came move outside of the utility peak. Here we reduce our peak demand during a morning peak by 20 percent, and that average demand during that morning peak is reduced by over half.

I really just tie this back into that energy value chain that I discussed in my first slide where we can cross over the barrier of the meter and partner with the utility to unlock new values. And just move to the final slide and just quick photo showing our thermal storage tanks. I like this photo as it gives perspective on how visible the central plant is to the public and helps show that this project is not just about providing energy efficiently but also about helping to educate the community on how their energy is produced and consumed. Thank you.

Sarah Zaleski: Great. Thank you so much, Nick and Brad. I really appreciate it. I think we're going to – well we did get a few questions specific to this project in the Slido, thank you all for that – but I think we're going to go ahead and turn it over to the National Western Center folks and then try to circle back to some of those questions at the end there to give you time. Thank you so much for sharing. With this, I'll turn it over to Barb and Laura to tell us about the National Western Center.

Barb Frommell: Great. Thank you so much, Sarah, and we're really honored and excited to be part of this panel, so thank you to Sarah and to the Department of Energy for inviting us and to all of you for being here today. I'm going to give you a high-level overview of the National Western Center and our carbon reduction strategies and then I'll let my colleague Laura get into some more of the technical details of our district and renewal energy system. So, next slide. I think you can skip that one as well.

So, first of all just a bit of background for those of you who aren't familiar with the National Western Center. The city and county of Denver is partnering with Colorado State University and the Western Stock Show Association to redevelop an area north of downtown Denver which has historically been used as stock yards, Denver's meatpacking district and the location of the National Western Stock Show, which has taken place every January for the last 115 years, believe it or not. The transformation will turn an underutilized part of Denver into a year-round hub for food and agricultural discovery, which we call the National Western Center. So, next slide will show the location of this site.

So when you fly into Denver you would pass this site on I-70 as you come into downtown or if you're heading west to go into the mountains, and this used to be really far away from downtown but now it is much better connected via multimodal transportation network, including a commuter rail station at the National Western Center, which is only one stop away from Denver Union Station.

So similar to the previous project we're kind of on that edge of a growing downtown. Next slide. This shows the existing conditions of the site as you're looking south toward downtown. You can see the South Platte River there borders about a half mile – along a half-mile stretch of this site, and then if you click forward we have a little bit animation in there.

This site is 250 acres in total and the first phases, which are under construction now, cover about 190 acres, and then for the future phase, which we call the triangle – we are seeking a development partner – that's about 60 acres. So pretty much everything we're talking about today is located in these first two phases. Next slide. And then this is a rendering of the campus looking north. We've got a couple of these buildings under construction already.

In total, the new campus will have approximately 2 million square feet of new event venues, indoor and outdoor entertainment space, three Colorado State University buildings which are focused on education and research related to food, water, and animal health, and then of course you can see the South Platte River there on the right and there will be a new six-acre open space along the South Platte River. Next slide. So the city of Denver is known for its climate leadership and back in 2018 set a goal to reduce greenhouse gas emissions 80 percent by 2050 using a 2005 baseline, and we have a new climate office which is leading the charge to help us both reduce greenhouse gas emissions but also while promoting equity.

And if you go to the next slide this is also reflected in the city of Denver's 100 percent renewable energy goal which seeks to maximize investments in renewable energy sources while also producing co-benefits such as workforce development or STEM education opportunities, savings on utility bills, and so that equity piece is really an important part of our city's climate goals. Next slide. At the National Western Center, one of the guiding principles of our master plan is to embrace an ethic of regeneration. So as we've considered options for carbon reduction we've tried to go beyond sustainability and toward really think about regenerative systems that give back to the environment and to the economy and to surrounding communities. Next slide.

The other line of thinking that has greatly affected our approach to carbon reduction is the notion of turning our liabilities into assets, and as you can see in the photo here this is one of our greatest physical liabilities on the campus and it's in the form of two very tall, six- and seven-foot wastewater pipes called the Delgany

Interceptor, and these currently run above ground along the river's edge. So obviously through our development we need to figure out a way to get those off the river's edge so we can build that six-acre open space, but in the process of studying that and working with Metro Wastewater Reclamation District, who's the owner of the pipes, we learned that there is more than enough thermal energy in these pipes to heat and cool the buildings on the campus. So once we learned that, the community and our leaders really challenged us to take advantage of this locally available and low carbon energy resource.

Next slide. So our energy strategies for the new campus have focused on four primary areas; energy efficient buildings, district heating and cooling using wastewater heat recovery and what I believe is the largest wastewater heat recovery system in the United States, and we might have to duke that out with McKinstry it sounds like but I think we've got that, and then renewable electric and community resiliency. So our talk today is really going to focus on the three latter of these, and then I have a couple more slides here where I'm going to talk about kind of our journey to get to district heating and cooling and then I'm going to hand it off to Laura to talk through these and provide some more technical information. Next slide.

Bringing district heating and cooling to a campus like this is quite a feat as you can imagine, and it has required some really hard work and dedication by numerous partners. Once our due diligence determined that wastewater heat recovery was a feasible technology for the campus one of the first things we did was execute an intergovernmental agreement with Metro Wastewater District that owns the Delgany Interceptor, and that IGA will result in the relocation and burial of those wastewater pipes, but it also secured our rights to the thermal energy in the wastewater. So that was a very critical early first step to make sure that we could realize this innovative idea. Then we also began a competitive procurement phase to seek a partner who would design, build, finance, operate and maintain the district energy system.

EAS Energy Partner was selected to enter into exclusive negotiations and to advance design during a predevelopment phase, and they are led by Enwave, which is a district energy operator, and then AECOM is their design team and Saunders Construction is their construction team. So I'm happy to announce that this last July, at the end of a long predevelopment phase and in the middle of a global pandemic, the campus partners were able to execute a suite of agreements to make this district energy, district

heating and cooling system a reality, and so construction begins on that in early 2021 and the system will be operating in 2022. Next slide. This slide shows the partners who are involved specifically in the district heating and cooling system.

And just for those of you who are interested in how something like this is structured I thought I'd go through what each role is. So again, Metro Wastewater is supplying the thermal energy. EAS Energy Partners will deliver and finance and operate the system for 40 years. They have entered into a long-range agreement, campus energy agreement, with the National Western Center Authority, which is a Colorado nonprofit organization who is responsible for operating and maintaining all the city-owned facilities at the campus. The Authority will own the district system, they will pay EAS Energy Partners monthly energy payments, and then they are entering into operating agreements with Colorado State University and the Western Stock Show Association who both own buildings on the campus and are off takers of the district heating and cooling system.

And then the city and county of Denver plays an important role by providing partial credit support to the Authority. Since the Authority is a nascent nonprofit organization this credit support was necessary for them to enter into a long-term agreement with EAS Energy Partners. So I'm going to pass this over to Laura so she can get into some more technical details of this district system and then also some of our renewable systems.

Laura Rip: Great. Next slide then. Thanks, Barb. I'm Laura Rip. I work as the campus energy director and work closely with Barb on the technical aspects of our campus-wide energy systems. So as a mechanical engineer working on this unique thermal system has been really exciting just from a technical perspective, but also really rewarding because it's bringing all of our campus partners, the city, the Authority, CSU and Stock Show closer to their climate goals and their building efficiency goals too.

So this sewer thermal system is going to drive down our carbon emissions of the site by eliminating about 90 percent of the gas heating that we would've had for these district-connected buildings. We're also using the system to provide cooling and project it being the largest sewer thermal recovery system in North America, which we're excited about. Next slide. So after confirming that the sewer thermal heat exchange or process would work for our campus during the request for information and request for proposal phases that Barb mentioned and having kind

of the sewer parameters well known, our energy partner EAS's first task was to quantify the building heating and cooling loads that the sewer thermal system would serve.

So they modeled all the buildings based on the owner requirements that we knew at the time. Many buildings hadn't even started design when we started this process, so that was a little bit of a challenge. They discovered that there should be about 15 percent of the time that the buildings need to be both heated and cooled, as you can see from this graph here. Not quite as fancy as the next graph. Next slide. So that simultaneous heating and cooling overlap drove the technical evaluation of what the central plant technology – what type of technology would be the most cost effective for the campus. So EAS evaluated whether sewer thermal that's freely available near the central plant site would be able to simultaneously produce – and could simultaneously produce that hot and chilled water could beat a natural gas system on a cost basis.

So they also evaluated whether a two-pipe or four-pipe configuration would be most appropriate; a two-pipe system where the plant is sending that condenser water loop to the buildings and then the building HVAC system converts that to hot water and chilled water loops at the building or a four-pipe system where that HVAC heating and cooling conversion happens at the plant and then the plant sends out a hot water and chilled water loop straight to the buildings. So their assessment of capital costs, operational and maintenance costs and utility costs showed that it was best to house the heat pump equipment in the buildings for our scenario and it was best to run the system off the sewer thermal exchange for the most cost-effective solution. Next slide.

So alongside EAS's technical evaluation was the city's total cost of ownership model where we looked at the all-in financing and operational costs for the system over the whole term of the deal, which is 40 years. So from the get-go the target was to have our district system be comparable to a baseline system, and most of our brainpower in that free development phase was spent defining a really clear baseline system and finding cost efficiencies in EAS's delivery of the district system construction, which was the cup itself but also the piping, district piping underground and what their O&M services could provide over the term. In the end the city, the Authority and the partners, CSU and the Stock Show, felt a 7 percent premium over a traditional gas system was worth the positive environmental and equity aspects of this project.

Plus, we all know gas prices are extremely low right now, and this model doesn't include forthcoming carbon credits, carbon taxes, or mandatory replacement of that gas equipment in the future, so we're pretty optimistic that our sewer thermal system will beat out traditional gas on a cost basis over the term in addition to all these positive environmental impacts. So here on the chart on the left you can see with a traditional system your main operational costs are the operation and maintenance of the equipment and replacement of that equipment, which are all shown in yellow, and then the utility costs are in green. And when we move to a district system you still have those major cost categories, but now you also have energy payments to EAS to cover their central plant construction costs, their O&M costs, which are shown in blue. So you can see the big difference there is those yellow bars, the O&M costs.

So even though the chillers are going in the buildings EAS is going to operate and maintain them as part of their energy service, so that is adding some economies of scale because we're only going to have one chiller maintenance contract instead of having each of the building owners go procure their own contracts for those services. They're also going to remotely operate their plant most of the time, so further reducing some of those operational costs onsite. The way we have this structured also ensures that EAS has to properly maintain and replace system components through a set of key performance indicators, so hopefully the equipment will stay in much better shape than if we go it alone. Next slide. So a couple of visual slides here on how the system works.

The sewer is sourced from the Metro Wastewater Delgany line that will soon be buried under our campus. The sewage temperatures migrate from about 60 to 75 degrees throughout the year, so those temperatures are much more stable and favorable than other thermal sources such as exchanging the heat with the ground for a ground source heat pump or water cooled – if the water's cooled by a cooling tower, and it's most certainly better than exchanging with the outside air temperatures like a typical air source heat pump would do, which is the most typical solution if you're trying to electrify your HVAC system. So the sewer is clutch here. Then the box there on the screening, so we're going to pull that sewer into a wet well, screen up some of the bigger solids and pump it up into the central plant.

There, a special heat exchanger system further macerates the sewerage and exchanges that thermal energy into a clean water condenser water loop. We usually call that our ambient loop. The

ambient loop then sends water between 51 degrees and 77 degrees to our buildings via underground, uninsulated HDP piping. At each building then the ambient loop is sent to the heat pump chillers and then we route it to the chillers condenser side first to produce cooling from the evaporator for the chilled water loops or to the evaporator side first and then reject heat from the condenser to the building's hot water loop, and then each chiller can be in either heating or cooling mode so we can do both at the building.

Those systems can leverage each other, which is pretty neat. Next slide. Then we have just an overview of what the central plant will be doing. So the sewer comes from the Delgany line represented there in purple and is exchanged to the green ambient loop. Then if the loop needs extra cooling at peak summer times we'll get a cooling boost from a set of cooling towers that are outside and then boiler heat is injected in red there during the peak heating times. So all in all the system is 3.8 megawatts of sewer thermal energy, and then we're reducing gas heating by 90 percent. Cooling kind of stays the same, but about 80-something percent of the cooling will be just from the sewer thermal.

This will serve seven buildings and over 1 million square feet of the campus footprint, and it's set up that we can expand for future and maybe add some extra features to the plant that can further boost efficiency. Next slide. More importantly though we're reducing carbon emissions by 2,600 metric tons, reducing water usage by 3 million gallons a year by eliminating cooling towers we would've had for the individual buildings, and we reduced the temperature of Metros Wastewater Plant effluence, which aids in protecting the ecosystems in the South Platte River. And then if the whole district system isn't exciting enough I'll tough on our renewal power plants regarding solar PV and campus resilience.

So, next slide. Our goal for carbon reduction for our electricity consumption is to define a clear pathway to get to 100 percent renewable electricity for the campus. So what we currently have planned and in the works for campus is in addition to this small PV array you see there on the maintenance and operations building, we've partnered with the city of Denver to install two community solar arrays on our first two campus buildings, the brand new stock yard event center and the renovated maintenance and operations building. So how it works is the city will apply for a solar garden with Xcel, our utility partner.

The city then installs that solar on our rooftops and other ones around the city and the power is sold to low income subscribers

through a slightly reduced rate, and then the National Western Center would also be able to subscribe to some of the electricity produced. Next slide. For the rest of the campus buildout we have a little bit of a ways to go just because all these programs and strategies change every other second it seems like, but we're partnering really close with Xcel, we have a great utility partner, and the city of Denver has relationships with Xcel that we're leveraging. To get to 100 percent renewable power we'll have to utilize several of Xcel's program for both offsite and onsite power.

The offsite renewables would come from first using Xcel's projected grid mix to certify that 50 percent of grid power from Xcel is renewable power, and then also subscribing to Xcel's offsite renewable power by applying to their Renewable Connect program. But then onsite options would include using Xcel Solar Rewards program for medium size arrays if we just directly install PV on our rooftops, and then that power is used directly at the buildings, and then partnering with Xcel on their community solar gardens where Xcel would install the garden on our rooftops and then send power to low income subscribers. Then we have the other options such as the Renewable Denver Community Solar Opportunity I just mentioned and then future power purchase agreements.

Those options are still on the table and change by the day. So, next slide. To complement those PV systems, our plans for a more power-resilient campus. Xcel is working to balance loads of our campus, which has a lot, especially during the stock show. So they're balancing those with four different feeders around the site, and so we have different options for swapping loads to different feeders if one of their feeders go down. So options that we're structuring around this automated feeder switching better enables an opportunity to add some of our buildings to a microgrid system. Next slide.

So the actual Western Center is one of several sites selected by Xcel for its Community Resiliency Initiative, so we're hoping to have one large event space or building and the central plant both served by a battery system provided by Xcel. So if one of the feeders has an outage and a backup feeder can't take the load, so we've got kind of a bigger grid problem, those buildings selected would be islanded and sourced by the battery, and then rooftop PV on that building would charge the battery during the day for longer term outages to sustain us a bit longer. So these big event venue spaces could host animals or people in a variety of different

configurations based on what type of environmental or medical or housing emergency is occurring.

So we're working through a lot of details on that still but really hopeful that the microgrid will come to fruition. Next slide. So just in summary, we are really thrilled to work on these carbon reduction technologies for our campus, not just because of the obvious environmental impacts we talked through but having an opportunity to bring more equitable solutions to our neighboring communities. That's through power subscription opportunities for those low income households, ensuring a percentage of the work for this district system goes to minority and women-owned business enterprises, other economic opportunities and workforce development for our neighborhoods, and then hopefully providing a resilient community center during emergencies.

We're also to have like the perfect conduit for showcasing these energy solutions through educational opportunities with Colorado State University, of course, and then partnering with the energy partner and the Authority who are already coordinating these energy outreach ideas. So, next slide. So that just – thanks for joining today and getting to hear about our project. The next slide has a couple links for National Western Center program and we look forward to questions. Thanks.

Sarah Zaleski: All right. Thank you so much, Laura, and thank you so much, Barb, for putting up these links too for us to find out more information about this very exciting project. I actually had an opportunity to tour it a couple of years ago and it's really amazing in just the size and the scale and the historical significance. Excited to see how it evolves. We're going to keep moving with our presentations just because I do want to make sure we have time at the end for Q&A and we only have half an hour left, so I'm going to turn it over to Shanti and Ben to talk a little bit more about this broader space of multibuilding projects and carbon reduction.

Shanti Pless: Great. Thanks, all. Yeah, Ben and I will wrap this up, talk about some resources and tools we've been working on as part of this, so if you go to the next slide there, I think historically as a – yep, next one after that. Yep. That's us. So historically as we think of the next slide, as we think about individual one-off buildings, you heard Brad say some of this and kind of one building at a time approaches, I think we've got a lot of these best practices out there for individual buildings, but the question is how do you scale this to zero energy districts, high performance communities? Lots of words out there.

The idea being taking the best practices we have for high performance individual buildings and trying to figure out how they translate over and to scale faster and quicker for zero energy communities. So we've been at this for a few years now trying to understand how to best do that, work on projects that are attempting to do this, to really understand their promising practices. If you go to the next slide, our folks at eco districts a while back have really recognized the benefit of working at a community or district scale and that it's not like a whole city where you have to figure out from a city scale how to reach these goals, so you don't get slowed down by the scale of it but it's more than one building. So the district is the optimal scale to accelerate sustainability as they call it, and so we definitely have seen that over the years working in these communities and we're really able to think about innovation and emerging best practices but also scale, right?

So if you go to the next slide – and Brad said some of this as well. I think you'll see good alignment across all these around the opportunities to unlock additional energy efficiency, additional scaling. Better planning always results in better products, right? So bringing these concepts into the early planning stages of a community, whether it's in a master plan or in a series of design guidelines, all of these communities have spent a fair amount of time thinking about their development, and so if you can get these energy strategies really built into that up from planning materials and process. You have an opportunity to get better planning for efficiency and sustainability. Of course, economies of scale come along with it and district energy systems, as you heard, that enable some of the low diversity.

You saw that with both National Western and the Catalyst South Landing project, talked about their coincident heating and cooling loads, right? That's the idea of waste heat capture and reuse, load diversity and not everyone's peaking at the same time and you can manage your utility interconnect better at a community scale. So all those are ideas I think we all have talked about, but it's great to see projects actually putting those in place and proving these ideas out. It's not just on the technology side. These are testbeds for new technologies but we're also seeing utilities engage and utilities some of these programs as well, and so there are utility program that are emerging across the US now that are thinking about how to offer up support, incentives, additional modeling, additional programs that can support communities and developments trying to think through this early planning.

And finally, as you heard from both McKinstry and the city of Denver on their innovative ownership models and business models in terms of development and how other party financing is brought to these projects. Go to the next slide. And so about four years ago Sarah and the Department of Energy came up with a Zero Energy Districts Accelerator, where there's a series of district projects all thinking about this. They're all in the early stages of planning their communities, and so both Catalyst and National Western were involved in the early days back in – what was that four years ago? 2017 now, where we started on this journey.

You can see the series of other projects across the United States. This is how the Department of Energy and Better Buildings have engaged in some of these deeper dives with partners over a longer three-year engagement, and so there's a series of these accelerators that have happened over the last few years, and so there's a three-year one for Zero Energy Districts Accelerator, and so in that – if you go to the next slide – definitely spent a lot of time thinking about the challenges of course in terms of what type of tools are needed to do all this great analysis. You'll hear more about that from Ben, my colleague here, and some of the tools that are being developed.

Utility engagement. If you don't have a willing utility partner it can be pretty difficult at this scale, as Brad pointed out in terms of the economics and the support necessary when you're designing power flows in the communities that are not normal from a utility distribution engineer. You might even get backflow and such and how to design utilities to enable this type of scale. Thinking through what energy goals, how to integrate them, what does it really mean to be a zero energy or carbon neutral community or district. Of course as we heard at the beginning, financing, ownership, governance models, especially when you've got districts with multiple owners in them. One or two owners in a community can be a little bit easier when you've got that spread across multiple owners.

Innovative models of ownership and management become critical and then how do you measure accountability for ongoing performance? If you go to the next slide, those are all things that all the partners are working towards and others, and as supporting and thinking on those challenges came up with a series of promising practices. We initially published some of that here two years ago in a paper here. It's kind of hard to see the link there, but it's Communities of the Future: Accelerating Zero Energy District

Master Planning. We were able to document some of these promising practices. Energy efficiency.

At first you heard lead minimums, right, or energy efficiency strategies that can enable, electrification strategies that can enable the district scale solutions to happen. I think that idea of a lighthouse project, your first project that you build in your community and your district is really critical to get that right because it sets the standard for all the future development in that community, and so getting that first project right and the strategies. Or if it's a starter district, as the Catalyst development has shown, the first building in is the starter district. It enables that starter district to be built for future development, so getting that first one right is really critical and we've seen that.

All these communities are thinking about district scale opportunities for capturing waste heat, whether that's from a datacenter or from wastewater heat recovery or even just shared ground source heat pump systems. The economies of scale really help in that strategy to make that a viable option for individual buildings. Of course, best practices around community and utility engagement are critical in all planning in addition to energy master planning in particular, and a series of innovative financing and ownership models that have come out of this that are documented and try to highlight – and you heard a few of those from earlier here. If you go to the next slide, so we took all that and over the last three, four years, in addition to the engineering district accelerator partners and kind of wrote it all down, kept track of all these promising practices, and as of yesterday I believe we were able to publish a guide that includes all these strategies, Energy Master Planning for High Performance Districts and Communities.

So all these promising practices we've tried to document and include based on examples of what others have done and include sample analysis, ways to do that analysis to figure out your feasibility of, say, a shared recovery system and such. There's a lot of materials that are already out there in this, and so we can definitely leverage International District Energy Association resources. RMI had some great business model resources that are all kind of incorporated throughout, but packaged up in a way across a series of strategies and example products across the US that are all trying to do this. There's a link out there. It's at the bottom of the slide. It looks like it got cut off.

Maybe we can put it in the chat here as we go. It was published yesterday, so we'll get that out. So if you go to the next slide, just

some screen shots of table of contents here as we kind of give you a sense of what's in this guide from just kind of introducing – what the idea is and how a planning guide – and why energy planning is important to pull in together as a team on energy planning. It's not just a typical master planning exercise that you would go through in terms of detailed energy feasibility and analysis necessary. Chapter three is a whole chapter on financial business models that are available and others have used to try and get through these barriers of how to fundraise and pay for all this.

Again, as we've heard, engaging your utility is a critical partner in this, and so a whole chapter on promising practices we've identified for utility engagement in the energy and high performance district planning. Go to the next slide. Chapters six through nine really are the technical meat of the guide where we try to deep dive into an analysis and planning of individual technologies, whether it's just the energy master plan itself and what that looks like to how to get energy efficiency incorporated early on in things like energy use intensity goals or lead goals required as part of design guidelines or set UI targets set in your master planning documents so that they're perpetrated throughout the whole process of the construction and development. A whole chapter in district energy planning and in particular some of these next generation shared ambient loop district energy systems.

If you go to the next slide, a full chapter on renewable energy system planning and feasibility, kind of where do you put all the renewables, how do you plan for that, how do you integrate those strategies, and a final chapter on some of the grid integration issues, electrical vehicle charging infrastructure at the scale necessary. Energy storage integration and such that are all possible at a community scale now. Wrapping up with a series of projects and communities that are in various stages of planning design construction operation for some case study – a couple pages of case studies in chapter 10. So on the final slide just showing that we've talked in two projects but they're all over the United States and this is just a subset of the ones that we were able to document sufficiently.

There's more out there as well, so there's a range of promising practices and examples to look to. With that, I'm going to turn it over to my colleague Ben Polly who's going to again give some of the details on modeling and tool development around this space. Thanks.

Ben Polly: Thanks, Shanti. So as Shanti described one of the key challenges identified by the accelerator partners was the need for advanced analytical capabilities to help design and optimize these districts. A variety of technical questions were being asked by district teams, ranging from simpler questions like what energy use intensity should be targeted in a certain climate to achieve high efficiency, and then given those energies intensities how much PV is needed to reach zero energy or to achieve a certain percentage in carbon reduction to more complex questions like is this district given its diversity in loads a good fit for a shared ground source thermal system? Would it be better to have one large central system or to have multiple smaller systems?

And so the DOE Energy Plus building energy simulation engine and Open Studio software development kit support the design of buildings at a kind of individual building level, but additional capabilities were needed to model collections of building, community energy systems and interactions at a district scale. So about four or five years ago at NREL we embarked on the development of URBANopt, which is an analytics platform for communities in urban districts. URBANopt is now funded by the Department of Energy through several DOE projects. We're collaborating closely with Lawrence Berkeley National Laboratory, several universities, and a variety of industry partners on the development of URBANopt. It's being built on top of Open Studio and Energy Plus, which I mentioned are the kind of individual building simulation engines, and then we're also integrating in some great capabilities developed in the Modelica Buildings Library to model some district thermal system capabilities.

URBANopt is a modular open source platform. As seen in the diagram on the right here, we're focused on the underlying analytics, open source analytics, and you can think of URBANopt as a software development kit sort of like a toolbox for commercial software developers. So our target audience for URBANopt is actually commercial software developers who want to develop different applications, graphical user interfaces, web services, et cetera, that leverage URBANopt in part or in whole for a variety of different community and district scale use cases to serve a variety of clients. Next slide. So kind of to summarize some of the key capabilities of the platform, URBANopt helps organize geospatial information about buildings and energy systems at this community scale, so think about buildings or locations or footprints, other things like roads and right-of-ways, information about distribution systems, community energy systems, et cetera.

URBANopt enables the creation of highly-customized analysis scenarios, so in most of these district projects there's usually a baseline scenario and then a variety of scenarios that the district partners want to investigate to look at how to best achieve their goals. It automates the generation of detailed physics-based models. So in URBANopt basically you input kind of a higher level or lower detailed information, which is often the case for a new construction district where early on in conceptual planning there may not be a lot of detailed information about the specific buildings. It may be more just the architectural program that has mixtures of space types and square footages, and it picks out information and then leverages capabilities through Open Studio to generate detailed physics-based models for each of the buildings in the district.

And then another key feature is that it helps manage simulations, integrations with other tools, and the aggregation of results by scenario. So in working with a variety of district projects, one of the things we continued to see was this approach where your individual building modeling was being done and their customized kind of one-off spreadsheets that were being used to often aggregate up results and to look at things at a scenario level, so a lot of this is enabling data management and aggregation across scenarios. Next slide. This kind of represents what we often see as a workflow for kind of multibuilding or district scale analysis. If it's an existing district or community often the first step is to be gathering information about the buildings, for example, footprints, numbers of stories, maybe some information from county assessor databases to try to get a good representation of the existing stock within the community.

If it's a new construction district then it's often a matter of bringing in information from architectural drawings or other renderings. That is all brought into the geospatial kind of central file format for URBANopt. That's a GeoJSON file and that kind of central file is then the starting point or the baseline, and then URBANopt, like I said, automates the generation of a variety of scenarios. So you might have, for an existing community, the baseline scenario might be the community as it exists today, and then for a new construction district it might be kind of the baseline against which all other results are compared, so maybe it's a minimum code scenario against which higher efficiency approaches are compared.

Then those scenarios are run, results are aggregated and compared to understand differences at individual building levels and at

district levels. Next slide. URBANopt is focused on kind of taking a modular approach, as I mentioned, and a lot of our modules are organized kind of by technology, so the center and kind of core focus is on buildings so that we're enabling analysis of efficiency and interactions between buildings at a district scale. But we also have some key focus areas in the project on grid interactivity, so in this area we're making integrations between the building energy models and models for distributed energy resources like PV and batteries and also models for electric distribution systems.

I'll talk more about that on the next slide. The goal there is to enable analytics where we can look at tradeoffs and synergies between building efficiency, building demand flexibility, distributed energy resources and the grid, so those things can be codesigned together to achieve a more optimal solution. Another key focus area, as I mentioned, is district thermal systems, and so we have a variety of modules that are in development there. That's where we're partnering closely with Lawrence Berkeley National Laboratory, University of Colorado Boulder, and we're developing models and templates to be able to analyze different generations of district thermal systems, so maybe more conventional systems that you might see say on an existing campus or medical complex with centralized natural gas boilers and chillers to more distributed systems like some of the ambient loop systems that have been discussed today where you have heat pumps and you have maybe opportunities for waste heat recovery. So we're trying to enable sort of more rapid modeling and more cost-effective assessment of these technologies for these district scale projects. Next slide.

So lastly, I just wanted to hit on some examples of how we're making some integrations between building modeling and other tools. One of the tools we're making integrations with is called REopt, which is developed at NREL, and REopt takes in a low profile either at a building scale or across a district. So that might be if it's a whole year it might be 8,760 electricity consumption values representing hourly consumption over the course of the year, and then it does a life cycle cost optimization and determines optimal sizing of PV and batteries. We're also making integrations with EPRI's open DSS tool, originally developed by EPRI and now open source, and in there we're able to model the effects of these technologies on distribution system performance.

And so with that said I just wanted to kind of wrap it up by mentioning that we try to highlight different analysis approaches throughout the high-performance district guide that Shanti

mentioned, and so those resources are available to browse through as well. Thank you.

Sarah Zaleski: All right. Thank you so much, Ben and Shanti. It was great. Congratulations on getting that guide published. Should definitely recommend it to folks. We'll put it again in the chat function for people to check out. It was just published yesterday, so congratulations. We have about eight minutes for questions.

There's been a fair amount of action on Slido, so thanks folks for adding your queries and questions there. I'm going to focus on just a couple themes that I saw and ask for very rapid questions because we only have eight minutes – very rapid answers. I did see a couple questions about embodied carbon and to what extent embodied carbon was integrated into some of the decision-making and planning for Catalyst and National Western Center. So maybe a quick 30-second from both of you guys on that. We'll go to Catalyst first.

Brad Liljequist: Okay, I'll jump in. Absolutely. I mean it was a big driver for us using cross-laminated timber construction. I should add actually that Katerra has built a factory in Spokane, a CLT factory. Ironically only some of that CLT – it just got stood up, so only some of the CLTs came from it. You know, CLTs are a real gamechanger when it comes to reducing embodied carbon. It's a big reduction.

And for our zero carbon certification we're just in the process of doing a calculation right now to determine what the reaction from baseline will be, and we'll be posting that out. So if you go to the Catalyst Spokane website we'll keep that up to date.

Sarah Zaleski: That's great. Thanks, Brad. Laura or Barb, you guys want to speak to National Western?

Laura Rip: Yeah. At National Western Center we just haven't been that aggressive yet. I think CSU is probably a little bit more at the forefront, so I'm not sure exactly what their evaluation looked like, but we're really trying to align ourselves with the city goals and I'm sure embedded carbon's going to come up real shortly as a requirement.

Sarah Zaleski: All right. Great. Thank you. There was also a few questions about utility engagement. So I'd love to hear quickly about – maybe we'll start with Laura and Barb from National Western Center. So I know Xcel is the investment utility there, if you can speak quickly

about how they've been integrated into the planning and execution of the project.

Barb Frommell: Sure. I'll take this one. Yeah, Xcel has been engaged early and often. We actually participated in their Partners in Energy Initiative early on and they helped us – they provided some technical assistance to help us with energy planning for the campus. We thought that they might compete to be our campus energy partner or our district energy partner and it was interesting; they decided to opt out of that but wrote a letter of support and said they would be willing to support us in any way we needed.

They have acted as a subject matter expert kind of the whole way through. They are now obviously working with us on some of our resiliency planning and our renewable energy planning, so they've been a phenomenal partner to work with. We're very happy to have Xcel in Denver.

Sarah Zaleski: Great. Thank y9ou. Brad or Nick, anything from the Spokane projects there?

Nick Edney: Yeah, sure. I'll take this question. Thanks, Sarah. Yeah, we likewise are very fortunate with our utility partner, and Avista really has been one of the key drivers for this project. The land on which Catalyst is now constructed was originally marked for a substation, and the approach that's been taken with this development helped defer or alleviate the need for that substation, which is really exciting. At a more technical level the whole concept of an eco-district and having centralized utilities and maybe centralized power distribution within the district grew out of collaboration between distribution planners and engineers – the utility and engineers at McKinstry is actually really kind of exciting getting those group of folks into the same room and talking through load codes on feeders and talking through demand codes on mechanical equipment and really seeing some opportunities come up where as building designers we design a certain way and operate a certain way based on what are simple or what the utility tariffs encourages us to do, provide incentives to do, but there is quite a lot of opportunity there to optimize how we operate to have impact on the utility system.

Sarah Zaleski: That's great. Thanks, Nick. So one final question, and this we could probably do a while webinar just on this, so if there's any highlights you can share, but there were a few questions about the business models, and so these are very complex projects with a fair amount of infrastructure involved and kind of who pays for that

and how those costs are recouped, and so if there's a few words that the projects are willing to mention about those. I know there's a lot you guys could say, so that's the challenge, is to see what you can say in a minute or so.

Nick Edney: Yeah, that has been a challenge. I think likewise being in partnership with the utility from the very get-go and the utility having the land has made it a little bit easier. They wanted it to be developed. And then having kind of a real control, not having to pull in different partners and get them on board, but really having a team all pulling in the same direction.

We've got a lot of innovation in these buildings, which has helped drive down the cost, and we see a lot of opportunity from what we're doing to keep operating costs low and expand. Like I said, invest in capital now for a long-term return.

Sarah Zaleski: Great. Thanks.

Brad Liljequist: If I could just add too, I think just trying to find value. You know, a lot of times we turn these things into zero sum games, like it's just about trying to reduce the energy footprint, but like if you're digging trenches already to put in thermal conduit, those sorts of things, well, make it a wired community and sell that. That might pay for everything.

Sarah Zaleski: Yeah, that's great. And just being aware of those opportunities. Laura and Barb, anything to mention from National Western Center?

Barb Frommell: Yeah. I think complexity is a good way to describe what we have going on. National Western Center is already pretty complex because we have so many different building property owners and operators on the campus, and so weaving in a new partner and an energy partner into that was really complex. We actually tried to simplify it as much as possible and stick to this notion of, yes, we're trying to achieve our energy goals but not at any price, and we are setting the bar of this, trying to do this at a comparable cost, total ownership cost, to traditional systems, and setting that bar and finding value where we could and working really hard to meet that I think got us really close. So in the end I think everybody was really satisfied with where we got and, yeah, it involved a lot of complex different funding sources but we were able to get it done, so we were really excited about that.

Sarah Zaleski: Great. Well, hopefully folks you can check out more about these projects and explore their websites and learn more about some of the specifics. I want to thank all of the speakers again so much for your time and sharing your insights and innovative projects with us. We have a couple of closing slides I'm going to run through really quickly. This is part of a webinar series.

Oh, really quickly I wanted to mention – so we – the office I'm with, the Buildings Technology Office has an open FO on the street right now. You can find it, EERE Exchange. We're investing about $65 million into a Connected Communities funding opportunity which really brings together a lot of the elements we talked about today, multi buildings integration really to ultimately drive down carbon emissions, so I welcome folks to check that out. If you go to the next slide, this is part of an ongoing series, so here we go. A little bit more about Connected Communities. Take a picture with your phone, go learn more information. *[Laughs]*

Next slide. So you'll see this is part of an ongoing series. Our next webinar is December 8th, a week from today. It's about saving energy and money with the Building Envelope Campaign, so a lot of work and innovation happening in the Building Envelope, so feel free to check that out. And then we also encourage you to check out the new Workforce Development portal for Better Buildings. If you're looking at the taking a next step in the career of energy efficiency you can get resources. That can be a great spot to look.

And then next slide is I believe around our on-demand webinars. So we have many other webinars like today's that can be found on the Better Buildings Solution Center. Just lastly I just want to say thank you again to all of our speakers and all of our participants for taking time to join us today. Again, these slides will be made available and so you'll have some more ways to reach out to these speakers should you have individual questions. Thanks everybody for joining us this week and enjoy the rest of your day.

[Speakers all say goodbye before signing off]

[End of Audio]