*Operator:* The broadcast is now starting. All attendees are in listen only mode.

*Solome Girma:* Hello? Good afternoon, everyone. I'm Solome Girma with the U.S. Department of Energy. I'd like to welcome you to the March edition of the Better Buildings webinar series. Thank you, all, for taking the time to join us for this session, and I hope this is an educational one to all of you.

Today, we have put together a list of wonderful panelists who we hope will give you a comprehensive view of the commercial zero energy buildings in the U.S., but also we get to hear from those that are actually creating the policies and building zero energy buildings. We will hear first from Reilly Loveland, who will describe the overview of zero energy buildings in the U.S. and New Buildings Institute, or NBI, has done great work in gathering this data, and she will be sharing this information with us.

Following Reilly, I will present on the work of what the Department of Energy has done so far in the two year accelerator program we launched, focused on zero energy K-12 schools and districts.

Next, we will hear from Nate Kinsey from San Francisco Unified School District. He will walk us through the district's zero energy goals and their plans on achieving these goals.

Finally, we will hear from Jason Robbins, who will share the success of Walgreen's on zero energy buildings from an engineering point of view.

So, let me introduce our presenters, and I'll start with me. Again, like I said earlier, my name is Solome Girma, and I lead the commercial zero energy building effort here at the Building Technologies Office in the Department of Energy. In my role, I convene key stakeholders, including state and local representatives, legislators, national laboratories, engineering communities and others to develop a robust adoption of zero energy buildings, but also to generate a necessary program framework to support the investment in cost effective zero energy buildings. I received my Bachelor's degree in mechanical engineering from Stony Brook University, and my Master's from George Washington University in engineering management. I am also a certified energy manager.

Next, we have Reilly Loveland from NBI. Reilly supports the project management team on various projects, including the Prop 39 Zero Net Energy Schools retrofit work in California as well as other K-12 related work. She has a Bachelor's of Science degree in geophysics, environmental science and resource management from the University of Washington, and holds a certification license in real estate, ArcGIS, LEED, and is a Green Classroom professional.

Next, we have Nate Kinsey. He is the San Francisco Unified School District's Energy Manager, where he works achieving the district's sustainability and zero net energy goals through energy efficiency capital projects, improve utility data analysis, and behavioral change programs. He has a Bachelor's and a Master's in environmental studies from USC, and swore he would never work in a school district like the rest of his family. I guess that plan did not work out, Nate.

Finally, we have Jason Robbins, who is currently the manager of Global Building Systems for McDonald's. Before joining McDonald's in 2016, Jason led the engineering design team for the State of the Art Building Systems at the Walgreen's Net Zero Project in Evanston. He's a Registered Professional Engineer and holds a Bachelor of Science degree in mechanical engineering from Milwaukee School of Engineering.

Thank you, all, for being with us today. And a little housekeeping item for everyone—before we get started with our presentations, I want to remind our audience that we will be on hold for questions until near the end of the hour. Please send in your questions to the drop box on your webinar screen throughout the session today, and we will try to get as many of them as we can. This session will be archived and posted to the web for your reference.

So, Reilly—over to you.

*Reilly Loveland:* Hi, my name is Reilly Loveland, and I'm with the New Buildings Institute. Thank you so much for attending this webinar today. I'm really excited to be speaking. If you wanna go to the next slide, that would be great. And you can even go one more.

So, the New Buildings Institute is a national nonprofit working to improve buildings for people and the environment via innovation and leadership in technology, policy, programs, and design. If you wouldn't mind going to the next slide.

NBI researches and defines leading edge practices and technology applications for high performance buildings and translates them into innovative and practical solutions for the utility, energy efficiency, and commercial building industries. If you wouldn't mind going to the next slide.

So, why should you go ZNE? ZNE is the next step in sustainable high performance buildings. With codes and standards continuing to ramp up, ZNE is a way to innovate now to save money in the long run. ZNE buildings contribute to stronger, resilient communities. Learning, working and living environments are more comfortable and productive due to connectivity to nature and passive design strategies. These buildings are high performing with low operating needs and operating costs, lower net energy costs and higher asset value. ZNE targets can also be specified early in the design process via RFPs and other design requirements to make it an easier way to accomplish ZNE. Next slide.

So, one way that we are tracking the success of ZNE is through our Getting to Zero Database. NBI works to identify, research, analyze, and promote commercial buildings that are leaders in low and zero energy performance outcomes, and as such, we maintain the most comprehensive database of zero net energy verified, emerging, and ultra-low buildings in North America—and I'll define those in just a little bit. You're able to search our database by location, building type, ZNE status, and energy performance metrics, as you can see on the left side of the slide. We're always looking for more ZNE projects, so if you have a project to submit if you've looked through our database, or just one off the top of your head, please do so through our online registry, or you can also e-mail info@newbuildings.org. On this page, our Getting to Zero page, is also where you can find answers to any questions you may have about the tracker or database. Next slide, please.

You may be able to tell through this webinar topic that ZNE is gaining momentum. Via our Getting to Zero database, we've been able to track the progress of ZNE buildings. So, for some background really quickly, the three types of ZNE buildings are: ZNE Verified, which is a building that has 12 months of metered data that shows zero net or positive energy protection over those 12 consecutive months; ZNE Emerging, which is a building that has publicly stated a goal of ZNE, but has not yet demonstrated that they've achieved that goal. This building may be in the planning or design phase, currently under construction, in operation less than 12 months, or has not yet quite documented the ZNE performance over 12 consecutive months. And lastly, Ultra

Low Energy is a building that has demonstrated significant energy reduction and technical progress towards goals of energy reduction, even though they may not have pursued ZNE originally or on site renewables. Next slide.

ZNE buildings have seen dramatic growth in the last decade, and especially in the last year. In 2015, we listed 191 ZNE verified and emerging projects, whereas this year, on our Getting to Zero list, we listed 332—that's an increase of 74 percent in a single year. Next slide.

ZNE projects are located in over 40 states and provinces in North America. Next slide.

ZNE buildings are feasible and currently exist in every climate zone in the United States. As you can see by the pie chart on the right, certain climate zones do dominate; however, every climate zone across the United States is touched by a ZNE building. next slide.

ZNE and Ultra Low buildings are possible across many building types, and some examples of these building types are here. These buildings include, on the top row from left to right: The IDeAs Z2 Design Facility in San Jose, California; the Richardsville Elementary School in Bowling Green, Kentucky; the NREL Research Support Facility in Denver, Colorado. And then on the bottom, from left to right: The Aldo Leopold Legacy Center in Baraboo, Wisconsin; the Center for Interactive Research on Sustainability at the University of British Columbia in Vancouver, Canada; and the San Francisco Public Utilities Commission Headquarters in San Francisco. Next slide, please.

Who and what building types are aiming for ZNE? Across the building ownership and building type spectrum, public buildings seem to be leading—particularly, educational buildings are leading the way to ZNE. Next slide.

As centers for change in leadership, the educational sector, particularly K-12 schools, are leading the market towards ZNE. You can see this reflected in all these of these pie charts. Next slide, please.

So, why schools? Why not? *[Laughter]* They are an ideal building type with low occupancy, they have sufficient land, and they're owner occupied. Going ZNE is fiscally responsible with tax payer dollars, and it puts more money back into the schools because of

lower building operation costs and reduced need for energy. ZNE schools have increased student performance with better occupant health, attendance, and improved teacher satisfaction and retention. They're more resilient to sever weather events and can create safe havens for the community, and as ZNE is not just about design but about operation, schools are the ultimate early adopters and set the example for future generations as operators of ZNE buildings. Schools house the next generation of environmental leaders, so going ZNE can provide hands on, project based learning opportunities for continued student growth. Next slide.

ZNE schools are growing at a rapid pace. Since 2015, the number of ZNE Verified, Emerging, and Ultra Low Schools has grown by almost 40 percent, with California, Kentucky, North Carolina, Texas, and South Carolina leading the way to ZNE schools. Next slide.

The buildings or schools that are successfully designed and operated to ZNE can be roughly a 75 percent reduction in EUI compared to CBECS. This offers a significant reduction in energy use and a significant savings potential. Next slide.

And because of these high performing efficiency strategies, the average ZNE building has an EUI of 22 before renewables. That is across the ZNE Verified, Emerging, and Ultra Low Energy buildings spectrum. Next slide.

Building cost varies based on location, building type, commodity cost, and the labor market—but the key takeaway here is that the costs are driven by many factors, including the growth of the ZNE market. ZNE buildings do incur an extra cost for renewables. However, our research suggests that ZNE can be delivered for around a 0 to 10 percent increased incremental cost. Next slide.

Some common technologies to approach ZNE include plug load reductions, passive strategies like daylighting, building orientation and natural ventilation, renewables like solar or geothermal amongst many others shown here. I'll just wait on this slide for a moment just so you can read through it. Next slide.

ZNE is tough to get to. However, there are many resources out there and available through NBI and many others. Next slide.

These resources out there are here to help you in whatever part of the ZNE process you may be in, whether you're just starting and formulating your initial plans, have some ideas, have approached

your district or your building owner/operator or have finished design and construction and need to move on to the operations portion. I mentioned our Getting to Zero list when I was talking about the database. NBI publishes a list every year of all zero net energy buildings. Again, if you have a project to share, please either submit through our online registry or by e-mailing info@newbuildings.org. Next slide.

There are also many existing case studies that show the feasibility of ZNE, and the key content in these case studies provided here—some are from NBI, some are from others—that these provide project overviews, energy efficiency features, project planning and design approach, and any lessons learned. These are really valuable tools. Next slide.

NBI has also published a communications toolkit for engaging key stakeholders and to communicate effectively the reasons for going to ZNE. This originally was developed for the state of California, but provides excellent resources for anyone across the nation or even in other countries looking to go ZNE. The toolkit includes a messaging platform for consistent communication around ZNE, an Intro to ZNE presentation that you can use to take to whatever stakeholder you're trying to communicate with, fact sheets, case studies, our *ZNE Action Bulletin* which is a quarterly newsletter, amongst many other pieces of information. You can pick and pull whatever you need to use to communicate ZNE. Next slide.

I mentioned that within the communications toolkit there are fact sheets that NBI has developed that target specific stakeholder or market groups to address questions and any terminology of ZNE for each group. These all can be accessed through the NBI website, or if you want to e-mail me, you're welcome to do that as well. Next slide.

We also provide presentation templates. These are primarily commercial, and they carry kind of general ZNE messaging and goals. However, they're incredibly helpful to help you engage your audience. You can also find previous agendas and presentations from other NBI workshops and events. Next slide.

I mentioned the *ZNE Action Bulletin*—NBI releases a quarterly newsletter with updates on ZNE, ZNE news, ZNE innovation, events and trainings. So you can sign up on the NBI website to receive it in your inbox quarterly. NBI has many, many resources, and others have many resources to effectively communicate, understand, and build and operate to ZNE. For more information,

visit our website or, like I said, feel free to e-mail me with any questions. Next slide.

And I have one more thing before I pass this off. We will be presenting at the Green Schools National Conference in Atlanta on March 21st and 22nd, and at the conference, we will be hosting with the Department of Energy a series of roundtable discussions to identify what schools need to be successful as they progress towards ZNE. And we want to hear from you—if you'll be at the conference and wish to participate, or if you still would like to participate but won't be at the conference, please e-mail or call me at the contact information provided. And as an added bonus, we will be raffling off two Amazon gift cards per roundtable. You also don't need to attend all three roundtables, just pick one. And again, if you won't be at the conference but have something to say, you're welcome to call or e-mail me and we can set up a time to talk. Please consider coming to provide your feedback—we're really excited to listen. Next slide.

And that's it! Thank you from me. My e-mail is a little cut off, but it's reilly@newbuildings, R-E-I-L-L-Y. Thank you so much.

*Solome Girma:* Thank you, Reilly. Alright, so let's move on to what the Department of Energy is working on in the ZE space. Next slide, please. Next slide, please. Next slide, please. Okay.

Alright, so in terms of zero energy, before I wanted to dig deep into what we are doing, I wanted to give the overview of the Department of Energy's bigger role. Our long term goal is to reduce U.S. buildings' Energy Units Index, or EUI, by 50 percent and then with the short term goal of 30 perfect by 2030. And our zero energy efforts help us in three strategic areas: With research and development, marketing stimulation, and codes and standards. We're working on each of these buckets, and we feel that zero energy fits in each one of them to accelerate the market. Next.

So, what does the buildings market, commercial market look like right now? So there are about 5.6 million commercial buildings comprised of about 14 principal building types, and then out of that, 1 million new buildings were constructed between 2000 and 2012, and there's really no slowing down. And then the average size of the building constructed in the 2000s is 17 percent bigger than new buildings constructed between 1960 and 1999. So what this means is, with more large buildings in the market, the more the demand for energy which is also making energy efficiency a critical part of the work that we do. Next slide.

So, once we, the Department of Energy started looking into the zero energy concept, we found that there was a lot of confusion in the marketplace. And to avoid that confusion, we felt it was our place to come up with a common definition for zero energy buildings, and we published this common definition in September of 2015, and we didn't do this alone, we worked with a lot of other market leaders, including ASHRAE, NBI, AIA, NIBS, and the National Renewable Energy Laboratory. Next slide.

And I'd like to mention that if you Google the common definition for zero energy buildings, you should be able to find this information. If not, the link is there, and again, this presentation is archived so you'll be able to receive the information with the link.

And so, what is a zero energy building? So, in aspiring to build a zero energy building, you must first focus on energy efficiency, so you have to reduce your energy consumption by 50 to 70 percent from your code. And we realize the gap between 50 to 70 is vast, but it's also because we're trying to cover the entire country, and we realize different states use different codes. But, basically, you need to first target your energy efficiency and then—so that, once you meet the 50 to 70 percent less code, then you are a zero energy building. And then, beyond that, if you are able to supplement the rest of the energy with renewable energy, then you are a zero energy building. So, moving forward, please know that we are working on both zero energy ready and zero energy buildings as we feel that energy efficiency is equally important than just putting the zero energy. Next slide, please.

So, by definition, a zero energy building is an energy efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy. And again, if you look at the scale, if you were to meet just the efficiency piece of it, you are a zero energy ready building and then, when you add the renewable piece, then you become a zero energy building. Next slide, please.

So, our goal at DOE when it comes to zero energy, or zero energy ready buildings, is we want to expand the demand, but while expanding the demand, we want to build the framework necessary to get there. So we are working on technical resources, you know, the case studies for pilot buildings, we are working on design guides, and then we are—now, we've decided to focus on schools and districts, and I will go into detail about that. But we are also working with other partners from the engineering and architectural

community, but also through other programs such as accelerators to build and move the market. Next slide. Next slide.

So, we'll start with zero energy accelerators. Our vision, the bigger vision of what we would like to see is, we want K-12 schools to provide healthy, dynamic learning environments and a resilient community assets that have zero to minimal energy costs. And so, through this, what we call a Zero Energy Accelerator Program, we launched this program last December, we want to show that zero energy schools are possible within conventional construction budgets. But also we want to help the partners that we have recruit states and districts that want them to establish EUI targets to drive their energy efficiency, and also provide resources to accelerate their zero energy goals and then get them faster than they would if they didn't get our support. Next slide.

So, Reilly just went over this. There is a huge opportunity in working with schools. In short, 1 in 6 Americans sets foot each day in a school, and it’s a unique opportunity to educate and shape the views of the new generation. But at the same time, outside of salaries, energy costs are the second largest cost to our schools. That’s a figure of a 6 billion, and some such it’s much higher, but that’s the figure that we have right now. And in addition, schools have a good replication potential because they have a very strong stakeholder involvement. And lastly, the zero energy schools are resilient schools which are critical to our community access, and we know because, you know, schools are always a major part of any community, and a resilient community is a preferred community. Next slide, please.

And you've seen the slide with NBI. Again, the market—as you can see, the market trends for schools is that they are leading the way for more zero energy buildings. Next slide.

In our approach in working with schools, one of the first thing that we did—it isn’t really possible to build zero energy schools from coast to coast within the U.S. So, to do that, we worked with our National Renewable Energy Laboratory, NREL, to conduct a technical feasibility study. And, with that, the study focuses on, you know, what are the technologies required to achieve zero energy ready, and then what Energy Unit Index or EUI targets do schools need to focus on to get to that zero energy goal? And this study was published in November of 2016, and the technologies are prioritized across the building subsystem such that design teams can readily integrate the ideas. Next slide, please.

To carry out the study and the NREL team use, it is listed what you can see in front of you, prototype characteristics which represent the average primary and secondary schools in the U.S. So you can—I'll give you a few seconds to look at that. Next slide.

So, basically, some of the best-in-class technologies are identified here: Classroom orientation on a long east-west axis, daylighting in classrooms to avoid additional lighting, demand-controlled ventilation, and energy-recovery ventilators using dedicated outside air systems. These are some of the technologies, and again, the list can be found in the detailed technical feasibility study. Next slide.

So, what does it look like? This is a load distribution for an average primary school, and as you can see, the goal here is to get to below 70 for the UI. Next slide.

To summarize, for all the 15 climate zones within the U.S., basically, you need to make these—what we found is, these are the target EUIs to be a zero energy building or a zero energy ready building. But it is possible to be zero energy in all climate zones—that's what the study found. Next slide, please.

So, with this program that we have, the Zero Energy Schools Accelerator, we have recruited about eight partners. We've got six school districts and two states, and we are also working with a variety of nonprofit institutions that are already working in this space, and this is the list. We are still recruiting and looking to work for more states and districts, so if you happen to know anyone or you are a representative from a school district or a state energy office, please reach out to me and we can see what we can do. Next slide.

Next, we will talk about zero energy districts. But districts, this is what we mean by it, is a self-identified geographical area, and our vision for these districts are, you know, communities with energy efficient resilience, cost-effective buildings and infrastructure that are common throughout the U.S. And with that, our goal is, we want to work with these districts in their master planning, but also the financing and ownership structure. And so, through that, we are looking to study their case studies, best practices, and pilot examples. And, with that, we mean how do we have EUI targets, other priorities such as resiliency and economic development, procurement model and design guidelines to ensure efficiency requirements are met by building design teams, integration of energy efficiency, district energy, CHP, and renewable energy

systems, and also establishing district energy building systems for those districts that are sharing energy among the districts. Next slide, please.

We decided to focus on districts because a lot of cities are setting aggressive energy transformation and resiliency goals, but there is no clear pathway to get there, and we feel that districts are one way to get there faster. That's why we chose to focus on districts. Next slide.

When we are talking about zero energy districts, we are not just talking about a group of buildings that are just built around each other, but rather districts that are innovative and that use innovative technologies to meet their energy needs in the most efficient manner. This means, for example, tapping into your industrial/sewer waste heat recovery system, or using combined heat and power or CHP or solar canopies for electric vehicle charging stations. These are some of the unique, innovative technologies that we want to implement for these districts to achieve their zero energy goals. Next slide.

So, through this Zero Energy District Accelerator Program, we are working with six implementing partners, and we are working with five other national partners. Next slide.

These are the list of all the six partners that we are working with. As you can see, it's a diverse group of projects, from low income housing projects to the development of an old Ford manufacturing site. And also, in terms of ownership, it's a public/private partnership, and we are studying these projects so we can learn from them, learn best practices, but also how can we replicate these kinds of projects throughout the U.S. Next slide, please.

So, the tallest oak in the forest was once just a tiny nut that held its ground. So, basically, what I'm trying to say is, the zero energy concept is still new, and as Reilly mentioned earlier, the majority of the buildings all started to be built just in the past year. So we've seen a lot of growth, and the market is transforming, and we have to start from somewhere, so I hope we are all in this and on the road to market transformation where these buildings are a commonplace rather than a one-off.

Thank you. If you have more questions for me that we may not get to, this is my information—please feel free to contact me.

*Nate Kinsey:* Great. Well, as Solome just wrapped up for us nicely, ZNE is a very new, emerging concept, and we've seen some success over the last 10 years or so. And so, SFUSD, with the passage of some local state legislation, really took it upon ourselves to come up with a long term strategy and how we were gonna do this as a district, and how we were going to accomplish this as a district for mainly retrofit opportunities. We're in a very dense urban environment here in the city and we're not gonna be building too many new schools, so it was a different challenge for us. Next slide, please.

And, as part of that process, the ZNE effort really led to a long term zero carbon goal, and ZNE is at the centerpiece of that, and so that's what we'll be focusing on today. Next slide.

So, when we presented to our board, we really focused on the four topics of—the planet needs bold action. As we know, climate change is occurring and it's occurring quickly, and even here in California with our ambitious greenhouse gas reduction goals, we aren't really doing enough yet to get there quickly enough, so we need to speed that up. There's good examples of jurisdictions all over the world, from California to Europe to Asia that are really stepping up on the issue of climate, and we wanna be a part of it. Other school districts are going ZNE. Boulder Valley has been a big template for us, in Colorado, and how—to think about the process of adopting ZNE goals. And down south in San Diego, they have a ZNE plan as well, so there's other schools working on this. And then we have examples of buildings, as we've seen today, that have gone ZNE and have done it successfully. Next slide.

So, how are we doing? How have we been doing on the energy side? Next slide.

The main way that we go through and do energy efficiency work, like many K-12 school districts across the nation, is through local bond funding and just general modernization. The sustainability office was created in 2008 and 2011 was the first real opportunity we had to influence the design and specifications of what our buildings and schools were gonna look like. And, for the most part, we did a decent job. This is data from four modernizations that have recently been completed and had enough data to do a comparison, and you can see the overall EUIs have gone down across the board. Next slide.

And we've done really well in natural gas. We're a coastal climate, heating dominant for energy usage. We actually don't have very much air conditioning in the school district at all, and so, for the

most part, we've done a good job of focusing on natural gas. The Monroe Elementary School example here had switched off of and installed—actually gone to electric heating, so that was why that big drop occurred. Next slide.

And here we are on electricity. Electricity is a different story. Because our buildings are very old, some of them reaching close to 100 years old, you're bringing all these new buildings up to code, which means you're adding exhaust fans, you're adding new pumps, you're having new laptop carts, new plug loads, and for the most part, what we're seeing across the board is that we can go to a site, overall in the EUI we do a good job, but on the issue of electricity, we really have to focus in on this. Now, the big caveat here is, these schools were built and constructed right before the LED price curve dropped off the cliff, and so we totally anticipate, once we get LEDs into new buildings, we'll see a major reduction. Next slide, please.

So, what about new schools? New construction? Like I said, for the most part, we're gonna be doing modernizations, but in the few cases we do get a new construction, how are we doing? This is a picture of Willie Brown Middle School, a brand new middle school that’s being built in the Southeast part of the city. Next slide.

And we really focused on chips, good design standards, following all the best practices, and for the most part, we are following the same trend here at Willie Brown. Natural gas, Willie Brown is the blue square and the gray circle dots are other middle schools throughout the district—doing a good job on the natural gas and the space heating side. Next slide.

As you can see on a square foot basis, very low compared to other middle schools. Next slide.

But on electricity, we're right in the middle of the pack. This is a big campus, lots of design challenges during the process. Next slide.

And we were seeing that, you know, even designing this building at 30 percent better than code here in California, on the electricity side, we are worse off compared to the rest of the middle schools throughout the district. Now, this site does have solar, and once we get the solar turned on and grid connected, we expect to kinda drop down in the middle of the pack. Next slide.

But this data that we saw from our 2011 school sites and our new construction here at Willie Brown was really the spark for us to focus on ZNE. Here's just another picture of Willie Brown. You can see kinda questionable design features of this curtain wall, which is facing south and west. We don't have enough tint on this, so the glare, and so this is the library. The librarian closes all her blinds, which increases electrical lighting usage. It's a great case study on how we can do better, and we've learned a lot of lessons from here. Next slide.

So the light bulb—the Light Bulb Moment was actually an NBI event here in Berkeley, just across the Bay. We went and took a tour of a ZNE library and heard them talk about how to go ZNE in school districts, why is it important, and what the state has as ambitious goals for accomplishing that. Next slide.

There was also the 7 x 7 x 7 Challenge, which was put on by the California Division of State Architects, which hired seven firms across the state to do seven case studies of seven campuses, in all different climate zones throughout California. This is a picture of a high school in Santa Barbara, which is very similar to the type of building that we have here locally in San Francisco, and so we used this as an example of how they could go about it and really brainstormed ideas. Next slide.

And we had a kickoff. In December of 2015, we invited WRNS Architects to come present on their ZNE library, which is down about 45 miles south of San Francisco, and to really introduce the idea to the school district to all the different departments, facility, bond, maintenance, and anybody else who was interested to know what the Sustainability Office was hoping to accomplish over the next couple years. Next slide.

And then, like any good San Francisco or Silicon Valley, we all hopped in our Teslas—just kidding—and did site visits around the Bay Area. This is a ZNE training center in East Bay. As you can tell, they have lots of solar generation and even some wind generation on site. Next slide.

We went down to the San Jose area and took a tour of a new construction auditorium and small ZNE classroom. Next slide.

And went out to the West Side of the city and took a tour of this nice building for the City College, which is naturally ventilated, and the purpose of all these site visits was to introduce different departments of the district to ZNE, to show them it was possible to

identify those common threads, to discuss the challenges with the architects and the maintenance teams and, you know, what was their district looking to accomplish? And for the most part, we left all those meetings with positive reviews and new ideas, and so we took all this and helped us with our big master plan. Next slide, please.

And so, like Solome touched on, you know, all these different definitions of ZNE and zero energy and zero energy ready and source and site—and so for us, what we decided is that, as a district, we're gonna really focus on the site energy as our definition, because it benefits us for a couple different reasons. Next slide.

One is, we have HHE Dam, which provides us not only with our water, but almost greenhouse-free electricity. And so, for a climate standpoint, right, the quickest and most effective goal for us is to get off natural gas entirely, and we have this nice backup to do that with. Next slide.

And we also, as a school district, said, “Is natural gas really that transition field of the future? Do we have the leakage rates here in California within our local IIU territory to justify the benefits that come with that?” And so that’s a big topic we really discussed with our different departments, and we landed on, we're gonna try and go all electric, total site energy use, all electric, and then lay on the solar systems as they become cost effective for us as a school district. Next slide.

And so here’s our district strategy and a quick snapshot. All new schools and new building construction will be ZNE ready. It'll be an all-electric site that’ll have solar-ready roofs for when that cost comes down and our rates go up. Modernization will be a nice, two-step process over the next couple bond cycles in which we're gonna touch a site for the first time and we're gonna really focus on the envelope and lighting and then go back and do the heating systems. And then, like I said—renewables in due time. We are a municipal electricity customer, we've been beneficiaries of very low electricity rates for a very long time. Now they're actually starting to come up enough to where the solar is making sense, and as everybody, I'm sure, knows on this call, solar costs have come down dramatically over the last couple years. Next slide.

Now, here’s our Stairway to ZNE. I touched on it really quickly on the last slide, but we're really focusing on implementing this process in a thoughtful, thorough way in which all the

departments—specifically, our Maintenance Department—really are on board with. And so we start down here, and this is our shared savings. This is our behavioral engagement work where we go to school sites, teach teachers how to use their sites, do data analysis, little mini-capital projects and really focus on the low-hanging fruit. Now we're gonna focus on the passive, you know, really insulating our buildings, double-paned windows, do that switch to LED district-wide. And then for heating, we're gonna slowly implement, over the next two decades, a switch from boilers to heat pumps, and then renewables and EV charging battery storage will all be a part of that future. Next slide.

And we're gonna do this process through our standards and through our normal bond modernization process, and that's, I think, what we as a district are trying to convey to other K-12s across the nation, that you can do this process, ZNE is possible, you just have to have the conversations and start those conversations with everybody in the district and really work them into your standard practices, whether that be your standard bond modernization or your standard facility project, just general maintenance. It is possible, you just have to have a thoughtful plan in which you as your school district and your departments are gonna go about it. Next slide, please.

And so, part of our recent bond process, we just had one pass in fall. We are gonna have ZNE modeling reports done for each one of the sites, and these are a couple pictures here. You can see, if you look closely, that each one of the engineering firms is gonna lay out different technologies, and how those cost impacts will be on utilities as well as how much they're gonna lower our EUI. We have a target EUI for all of our sites of 20, and that's what we're really handing over to the architects with some guidance through an OPR and say, "There you go, this is the goal—show us the way you're gonna do it." The other big benefit from these reports is, we're gonna be able to take these recommendations, whether it be electric, domestic, hot water heater or a zone level heat pump and work with our cost estimators to see how that will work within the budget of the bond process. Next slide.

And so our first ZNE retrofit opportunity will be Garfield Elementary School. This is one of the PG&E Prop 39 ZNE pilots. This site has rooftop units, just standard furnace units with air conditioning. We're gonna be switching over to VRF, or a VRV system and really layering on the solar panels here. We expect each one of these different roofs to be completely covered with solar close to a ZNE. Next slide.

And then our new construction opportunity will be at Claire Lilienthal Elementary School. We're gonna be replacing these bungalows—right here, you can see, on the left hand side—with a new building construction. Again, that will fall into the ZNE Ready category in which we're not gonna go ahead and layer on the solar right away, but it will be constructed with a goal, a target EUI of 20. Next slide.

But why stop there? Why stop at our buildings? Why not look bigger and beyond and really go after all our carbon emissions and greenhouse gas emissions? So, facility energy use, which is primarily the natural gas for boilers and domestic hot water heaters, makes up about 70 percent of our total greenhouse gas emissions. The other third of that comes from vehicle fuels, and we have a small vehicle fleet. Next slide.

And we're working with the different departments to really implement electric vehicles, and those are coming down to a great cost. We have a great little video of us getting stuck in an electric van going up one of San Francisco's hills. Technology is getting there, it's improved. They actually did the update, which allowed us to zip up the hill the next day—but we're really looking to implement this again over this long term period over the next two decades. Next slide.

And we're gonna be working with our local bus transportation to implement renewable diesel fuels, and that will be part of our next bid contract with them. Next slide.

And so here's our carbon neutrality or zero carbon policy. Effective immediately, we're gonna design buildings to be ZNE that are gonna be new. No new gas heating systems will be installed. This will be major overhauls during our bond modernization process, and we're actually working with our local utility commission to retrofit opportunities when boilers do fail outside of that cycle to install VRF for heat pump units.

By 2020, we're gonna focus on only buying new electric vehicles. All our diesel buses will be burning or using renewable diesel, and we have an office goal of reducing our natural gas and water use by 30 percent. By 2030, district-wide, all vehicles will be emissions free, and upping that percentage to 50 for natural gas reduction and water usage. And then by 2040, the big goal is to no longer use fossil fuels for heating or transportation throughout the district. Next slide.

And that's a quick wrap up of what we're doing here. Hopefully this is kind of inspiring for other school districts, and I'll be happy to answer questions as they come in. My contact information will be on the last slide as well. Thank you.

*Jason Robbins:* Hi, this is Jason Robbins. I'm currently with McDonald's, but I've only been so for the past six to seven months. Prior to that, I was with Walgreen's for 12 years, where I got to start my career, and I got to end it with one of the most personally rewarding projects of my career, which was the Walgreen's Net Zero Building in Evanston. Next slide, please. Next slide.

The vision for the project was written by our corporate person, but basically, it was to create a showcase for innovative and sustainable high performance retail design. The rest of it is all fluff, but some of it does have some meaning. But it was basically, build the best building that we could with the most up to date designs and most energy efficient ideas that we could come up with back in 2012. Next slide.

This is what the building ended up looking like. The elevation is facing west, so we have quite a bit of west facing glass, which was not the best energy decision from a modeling perspective, but gave the look and feel that we were looking for from a building to really represent what we were trying to do. Next transition.

There's some site features here that, if we peel back what the finished façade looks like, you can see the amount of steel and structure going on inside of that building to support the unique kind of visual aspects that we're going for architecturally as well as, you can see, the turbines there, and we did native and adaptive plant species. In the parking lot, we did rainwater collection, which, you can kinda see the cisterns there in the picture. Next slide.

Our project goals were to be the first net zero energy retail store in the U.S. Retail stores are pretty challenging for net zero because they are occupied high percentages of the year. This one—this store is occupied almost 5,500 hours a year, which is a lot more than what a typical office building or school or some other building types. So that's a huge challenge in terms of operating load. That check mark is in yellow, because we have not yet had a 12 month period of time in which we were exactly net zero or more, but we also wanted the project to be LEED Platinum, to be a Better Buildings Showcase Project, Green Chill Platinum which is

an EPA award for innovative use of refrigerants or reduced refrigerant use, Energy Star, and we want—we needed to open before Thanksgiving in 2013, which was just 14 months total for design and construction, which was a mistake, in retrospect. Next slide.

So our energy reduction strategies are gonna mimic pretty much what you've heard throughout all the other presentations. We needed an ultra-highly efficient mechanical system as well as refrigeration. We have a walk-in cooler and freezer that does both merchandising and storage of product, and on this location, it was nearly half the length of the building. We used eight geothermal wells, each 550 feet deep, and we also used all LED lighting on this project, even though it was not quite kind of ready to go full stream in terms of every single fixture, we did go ahead and make that decision back then to go all LED.

In addition to LED, we looked at doing some different things that you can do with LED versus fluorescent and that's directionalizing the lighting pattern—so really going to the next level of lighting design. With LEDs, you can really play with where the light goes, and we were able to get our lighting level down to 0.7 watts per square foot in a retail space—and you'll see a couple pictures that show really how bright the space is, even with that low level of wattage.

We did daylight harvesting—the first Walgreen's ever to have operable windows that operate on actuators. We had five separate dimming zones. Again, that was probably a little bit too complex. The dimming system, we had some disco parties with some strobing lights, so if anybody's ever played around with dimming systems, they can be a little tricky.

We did a revolving door, which is not typical for a Walgreen's, but did save quite a bit of energy in those winter months for infiltration. And we did a full blow building automation system with every single circuit monitored for energy usage so that we could understand how the building was actually performing versus designed. Next slide.

So, my one thing that I can go back to after doing this project was that I tried to keep everything very, very simple, but some things can't be made too simple. So keep everything as simple as possible, but not simpler. Next slide.

And that brings me to what our mechanical system looked like. So, it does not look very simple, but when you look at that, this is the total schematic of everything that gets hot or cold in the building gets run through this one machine. Next slide.

There's a picture of that up on our mechanical mezzanine, what that looks like in real person, and that space is publicly tourable. Next slide.

So this is the schematic of that system, so it doesn't look as scary like this, but basically, all of our hot water, domestic hot water, heating, chilled water going down to our freezers and coolers with direct CO2, and all of our geothermal loops are tied in through this one transcritical CO2 rack. Next slide.

So the green highlighted pipes here are all the geothermal connections, the blue are chilled water, the red pipes are hot water and domestic hot water. And that's how they all integrate back into this one kind of thermal management system for the building, so all of the heating, cooling, and refrigeration loads are done together. Next slide.

The building wasn't just about trying to achieve net zero. We really wanted to do everything possible to have kind of an environmental awareness showcase, so the existing building that was demolished, we recycled 84 percent of it. We used adaptive plant species, all low flow water fixtures.

We collected all of our storm water on site into the cisterns and didn't discharge any into the city's storm water system, which is a pretty big issue in the area of Chicago, because as the cities have grown, the storm water systems have not, so we tend to overwhelm city storm water systems in the area. Low VOC fixtures and finishes were used as well as we put in electric vehicle charging stations for people with those Teslas that are so cool to look at, they have a place to charge. And then we also did educational signage throughout the site, including outside, inside—basically, anywhere a customer could go, there was signage. And that ended up being more important than we even thought, because it was one of the main ways that we interacted with our customers. Next slide.

So the results, you can see, at 100 percent what our typical Chicago average EUI would look like, we did our first geothermal store in Oak Park, which is also a Chicago suburb, and we achieved roughly a 40 percent energy reduction just by doing geothermal. The detailed energy model on the right is where we

hope to be, which was a 60 to 70 percent reduction and where the first 12 months landed in, which was just a little bit better than the geothermal store. Next slide.

This is the 12 months, the first 12 months of operation. The blue is our actual net energy usage and the green is the predicted, so you can see that we weren't too far off of where we wanted to be, and generally the curves kind of look like each other, it just didn't do exactly what we thought, and we continued to learn why. Next slide.

So, our typical EUI in Chicago is 105. Our predicted through all of our modeling, based on what we knew when we were designing it, was to be an EUI of minus 5. The first year of operation we had an EUI of 20, and the last 12 months, or 2016, we had an EUI of 15. So we're still a bit above net zero, but one of the things that did not get accounted for was those electric vehicle charging stations.

We didn't predict that they would be used as much as they had been, but we have a Nissan dealership just a few doors down, and they found out our charging stations are free, so they got used quite a bit more than we expected. About—if you remove the electric vehicle charging stations from the building usage, the EUI drops to about 5. So there's a couple things that are still going differently than expected in the building or that are being worked on to address, and we hope that, within the next 18 months, we'll have 12 months of net zero performance. Next slide, please.

So overall lessons learned is try not to rush this. Commissioning is very important and it needs to happen before you occupy. Engage your contractors as early as you can, and kinda try to expect the unexpected. But this was a fantastic project to work on and it was really cool to be a part of it. Next slide.

So this is a picture of the inside of the building. You can see that glass on the back wall where that's the mechanical mezzanine where that's publicly tourable space. You can go up and see what's going on, and you can also see the clear story windows between each elevation. Those are the operable windows, so those open and close as controlled by the building automation system. Next slide—or sorry, that's all, and if you have any questions, please feel free to e-mail me, and there's gonna be a link on the Additional Resources page here to a time lapse video of the demolition and construction of the project.

Thank you.

*Solome Girma:* Alright, thank you, everyone. Alright, let's go ahead and get some questions answered. I know, I understand we're running out of time, but I wanted to still, for those that can hold on for a little bit, I want to ask some questions. Reilly, over to you first—have there been any cases where ZNE was achieved in a building without the use of RPV?

*Reilly Loveland:* Um, no. *[Laughter]* That's always a tough question. There are very low EUI operating buildings. The one off the top of my head is the Bullitt, which I think has an EUI of like 10 or 12. It depends on the building type, too. Like, there's some passive houses that are probably also operating at a very low EUI. I hope that answers your question.

*Solome Girma:* That 10 percent incremental cost referred to upfront costs only, or is that net of energy cost?

*Reilly Loveland:* That's net of rebates and other incentives that are taken into the upfront cost.

*Solome Girma:* Thank you. Some questions for me are—can any of these ideas about zero energy resilience help supporting schools be deployed among other students, teachers, and parents, toward decision makers to higher ideals of construction?

That's exactly what we are trying to approach our Zero Energy Schools Accelerator frame with. We want to arm the districts in the state that we are working with on how to best, you know, engage with their stakeholders. How do you add the zero energy lens into your curriculum, but also into your ___ and architectural design as early as possible? But definitely, we know how to be engaged in your community as well as parts of the accelerator program.

Will Better Buildings have a webinar for residential zero energy homes? At this point, unfortunately, I do not know, but if you were to go to our Zero Energy Homes website, I'm sure you'll be able to see as much information as possible and try to sign onto their, EERE's blog to get more information.

Next question for Nate—what is the biggest challenge to getting a carbon neutral policy of your district?

*Nate Kinsey:* So, we went to our board and the board said, "Make it stronger," so they're on board. The big concerns we have, as many people have brought up, is costs—you know, there are incremental costs of

doing this, we're really using our next bond process to see what those costs are gonna be like. And then the other thing that we're very, very cognizant of is the maintenance issues that come with this. School districts are chronically understaffed in their maintenance departments, and so that's why we really wanted to focus on those passive technologies first. Really tightening up our building allows us to run our systems less, allows us to design smaller systems, which makes it easier on our maintenance staff to maintain. So cost and maintenance—big concerns.

*Solome Girma:* Okay. The next question is—in San Francisco Unified School Districts, are they funding solar through PPAs or purchasing solar outright? What does the electric rate cost for solar PPAs have to become for installation of solar PV have to become so installation of solar PV is cost effective?

*Nate Kinsey:* So, we have a rate this year of 7.5 cents, roughly, and we have arrangements with our local municipal PEC where they install solar on our sites, but that doesn't necessarily benefit our utility bills whatsoever. We purchased one through a bond modernization outright and have yet to get that online. But, as those rates increase, we're starting to see, we're expected to go up to around 13 cents per kilowatt hour, and at those rates in California with the ITC, other firms are offering some pre-paid PPAs below the 10 cent mark.

So we are interested in the PPA and also kind of exploring the outright purchase model. Yet to be determined for us, but definitely a very important piece of the puzzle.

*Solome Girma:* Thank you. Question for Jason—what features in this score is Walgreen's now consistently including in new stores? All LED, revolving door, or any others?

*Jason Robbins:* There's a few features. All LED was one of them. Now all new stores for Walgreen's design are all LED inside and out, so for the site and all the buildings. There's a couple of features that we didn't really talk about, but low flow fixtures for water. There is a daylight redirecting film that we used for our lighting strategy that's being used any time where we have a lighting issue like that, as well as natural ventilation has been done at a few more locations, but not at all.

So there is a few, but the LED and some of the daylighting strategies were the main ones.

*Solome Girma:* How much was the premium and cost for this Walgreen's versus a regular store, and how many years until the added cost is paid out, paid for out of the energy savings?

*Jason Robbins:* That one's a little tougher to break down, but the premium for all of the items that contributed to net zero, like the mechanical system, solar, the wind turbines, and any additional installation was about $1,000,000.00 versus a $3,000,000.00 typical construction cost, so about a 33 percent increase. Although this building did cost more than that to build, there were a lot of elements that had nothing to do with those aspects of the design. For instance, we had to clean up several underground storage tanks that we found hidden on the site that cost a lot of money, and some of the structure that was more architectural than anything. So it was about $1,000,000.00 in the energy saving technologies.

*Solome Girma:* And one more question to you—what's McDonald's doing toward net zero energy?

*Jason Robbins:* McDonald's is currently investigating net zero. One of the things that's quite different from a standard retail store is the full commercial kitchen, which is a very large, has a very large energy density, and there needs to be some additional developments in some of that technology in the kitchen before we can get the EUI in the ballpark where net zero can be attempted. So we're working on developing those technologies for the kitchen side to make net zero possible for a restaurant like McDonald's.

*Solome Girma:* Thank you so much. I understand there were a lot more questions than that—I apologize, as we are running out of time, I need to end the question and answer session right now, but please feel free, we will have all our e-mail addresses on the following slides. So please feel free to ask us those questions. So, next slide.

Hopefully you will join us for the next Better Buildings webinar series. It's on wastewater matters, and it will take place Tuesday, April 4th, again, from 3 to 4 p.m. Eastern time. Next slide.

And I guess more importantly, we would like to invite all of you to join us for the Better Buildings Summit taking place in Washington, D.C. May 15th to the 17th. This is a national leading, we're leading organizations across key sectors to showcase solutions to cut energy intensity in their buildings. It is designed for partners and stakeholders to exchange best practices and highlight demonstrated market solutions with an equal emphasis on discussing future opportunities for greater energy efficiency in

American homes and building. So please take a look at the website below and sign up and join us for this summit. Next slide.

In front of you, you will see all our information, with e-mail addresses. Please, again, feel free to contact each one of us if you have additional questions or any comments.

With that, I would like to thank our panelists very much. Thank you very much for taking the time to be with us today, and if you would like to learn more about the Better Buildings challenge or alliance, please check out our websites or feel free to contact Amy Konigsburg or Holly Carr, and her e-mail is also listed on here, directly on the e-mail shown. I encourage you to follow the Better Buildings Initiative on Twitter for all our latest webinars or activities, and you will receive an e-mail notice when the archive of this session is available online.

Thank you, everyone, and have a wonderful rest of your day.

*[End of Audio]*