[The broadcast is now starting. All attendees are in listen-only mode]

Rois Langner: Hello. Welcome to the Better Buildings Alliance Renewables Integration Technical Research Team biannual team call. I hear a little bit of background noise right now. If you are on your phone make sure your phone is muted at this time. Thank you. This is Rois Langner from the National Renewable Energy Laboratory. I'm the new technical lead for the Renewables Integration Team. And just a brief background to start, at the Better Buildings Alliance, as many of you already know, serves as the platform for commercial building owners, managers, and industry partners to connect with technical experts and share and deploy innovative and cost-effective energy savings solutions.

The Renewables Integration Team has a webpage that can be found on the Better Buildings website. The link is provided here in the top right of this slide, and please note that these slides will be distributed after the call. Whoops, sorry. Went one slide too fast. And we're diving back into this Renewables Integration Team this year with a lot of exciting new goals for the team. The goals that we plan to focus on are really looking at the strategic use of renewables in our commercial building stock, looking at battery and thermal energy storage, building load flexibility and grid coordination to better understand how our building stock can become more of an asset to our power grid, especially as more and more renewables come online.

And of course, our goals are to develop and deliver more impactful resources, information and guidance on these topics to building owners and managers to help push the market forward in these areas. Sorry, one more thing on that slide. With that we would like to hear from you in the audience, our members, to get feedback and opinions and suggestions on additional topics that we could focus on as part of this team, and during this call we'll leave time at the end for some Q&A and discussion, and we really encourage you to participate in that. And if you have additional thoughts on the Renewables Integration Team topics that we cover today you can always email me directly with any comments. My email will be provided in a following slide.

Our agenda today will include brief introductions to our Renewables Integration Team, an overview of DOE's research interests and stakeholder efforts with the utilities and state policymakers on building load flexibility and grid coordination. This will be presented by Monica Neukomm, who is a senior policy advisor in the Office of Energy Efficiency and Renewable

Energy in the US Department of Energy. Then we will launch into our technical presentation by Cara Carmichael and Matt Jungclaus from the Rocky Mountain Institute, and also Kinga Porst Hydras will be presenting from the General Services Administration or GSA. They will be presenting new research conducted with GSA to understand the value of commercial buildings to utilities in providing a resource for load flexibility and capacity to respond to demand requests.

Just a little bit of background on our presenters today. Cara Carmichael is a principle with Rocky Mountain Institute's Buildings Practice where she focuses on net zero carbon solutions and deep energy retrofits in the federal commercial building sector. She is leading RMI's efforts on grid-interaction efficient buildings and the value proposition to building owners. Matt Jungclaus is a professional engineer and a manager with Rocky Mountain Institute's Buildings Program. Matt is managing RMI's grid-interaction efficient buildings analysis for the GSA. He also leads several of RMI's city and district scale net zero energy projects. And Kinga Porst Hydras is a high-performance building expert in the GSA Office of Federal High Performance Buildings with particular focus on energy efficiency programs, renewable energy, submetering, and indoor environmental quality.

So we're really excited to have them. I think this is gonna be a really interesting technical presentation today and paired with Monica Neukomm's overview of DOE's research in this area as well. Leading into that we'll leave at the end of the conversation, as I said before, a good 15 to 20 minutes for Q&A. Again, we welcome your participation and really hope to generate a good discussion on these topics. Please note that we're also recording this call and slides will be sent out after the call as well as a link to this presentation. All the attendees should be muted right now, but we can also unmute you at the end so that you can participate in the discussion.

So to do so you will need to click on the "raise your hand" button and enter the unique audio PIN that will be provided to you. Otherwise, you can also type your question into the chat box, and if you think of additional thoughts after the call feel free to email me directly again. So, quick introduction to the team. Again, I'm Rois Langner from NREL. I'm the new technical lead for the Renewables Integration Team. I'm an architectural engineer and I've been at NREL for almost a decade and actually have been leading the Better Buildings Alliance Plug & Process Loads Technical Team for the past six years, and that team has now

transitioned under leadership of my colleague Dr. Kim Trenbath, so I'm very excited to be a part of this new team as it's very – really relevant and interesting topics that we'll be talking about as we move forward.

We do have some team support from Navigant, including Andrea Romano. Andrea's work focuses on helping clients make decisions regarding utility-scale renewables and distributed energy resources. Her areas of expertise include renewable energy, community solar, storage, electric vehicles, and zero net energy buildings. She is currently working with several corporate clients to develop renewable energy strategies to reduce their greenhouse gas emissions through the procurement of renewable assets. We also have Bill Goetzler who is a managing director in Navigant's Energy Practice. His work focuses on energy efficiency and renewable energy, providing technology and market assessments, policy analysis, and strategic planning assistance for government agencies, utilities, and manufacturers of products such as HVAC and refrigeration equipment, appliances, water heating systems, lighting, building control, and distributed and renewable energy systems.

So those are our team players for the Renewables Integration Team. Again, feel free to email me directly or Andrea or Bill as well. And without further ago I'm gonna hand the mic over to Monica Neukomm at the Department of Energy. Monica?

Monica Neukomm: Great. Hi. Can you hear me okay?

Rois Langner: Yes, we can hear you.

Monica Neukomm: Great. Hello, everyone. Thanks for inviting me to participate in this discussion today. I am going to give you a quick overview of our work that we have been leading for about the past year and a half on grid-interactive efficient buildings. I work in the Building Technologies Office and support the coordination of this work. If we want to move to the next slide. Great.

Before I hop right into describing what a grid-interactive efficient building is, I wanted to just give a quick explanation of the why, the why we're doing this work, both from the building owner and grid perspective. You know, we've increasingly heard building owners know the importance of storage and renewables and wanting to better understand the role of integration and how to optimize and understand those technologies along with the role of building technologies. There's also been an increased importance

on resilience. And as adoption of control across building owners increases, enabling the building to optimize for building operations, help with comfort, and also increase savings opportunities and hopefully decrease demand charges, that has opened up more options about how to change building operations.

And then sort of mirroring that on the grid side, there's the increasing for resilience, peak demand needs, and the increase of renewables in sort of working to decrease some of the peaks of rebuilding from more renewables, and so BTO has been working to further explore options that will help with affordability, storage, and integration across these different technologies, and we call this work our grid-interactive efficient buildings work. These are the research initiatives, and really the vision of it is the integration and continuous optimization of DER for the benefit of building owners and occupants as well as the grid. And so this picture just sort of depicts what a grid-interactive efficient buildings would look like. I think the important thing to call out here is the sort of heart of this picture, the control system, building _____ management system that has inputs from sensors and controls that are, you know, allowing to optimize for occupant patterns, preferences, utility price signals, weather forecast, et cetera.

And I would just note that in this picture we have, of course, more of an advanced building technology suite from HVAC system, connected lighting, dynamic windows, et cetera, that'll all be optimized to meet occupant grid needs; but of course a smaller set of measures are more realistic in a building and the energy management system might not be as sort of advanced as this. And Cara will provide a summary of more measures, you know, that might be realistic in a building today. This is somewhat looking into the future. So then moving to the next slide, I'll just run through some of the key characteristics of a GEB. So we call grid-interactive efficient buildings GEB.

First, the buildings are energy efficient. The – our GEB work really builds on all the work that we've done at BTO on energy efficiency and then sort of take it to the next step to layer in flexibility. So the buildings are efficient, of course they have high-quality wall, windows, appliances, and optimized building design to reduce both net energy consumption and peak demand. Second, they're connected. So then you have the ability to at a minimum sort of receive signals to understand grid needs and sort of the time requirements, and situations may need to have two-way communication where they can send information back as well as, as I've sort of noted before, the ability to be smart, so being able to

use data analytics and as seen in optimize controls to manage behind-the-meter DERs in a way – you know, sort of the way you're optimizing for building owners, occupant comfort, et cetera, different aspects.

And suddenly they're flexible. So they can be – building energy loads can be shaped to optimize for reducing shifting or modulating energy use. So we move to the next slide. There we go. So this just sort of walks through what a grid-interactive efficient building can provide, which we call demand flexibility, and these are some of the different sort of demand flexibility modes. So we talked about efficiency, of course the ability to – for ongoing reduction in energy use, and then at any given level of efficiency in a given baseline mode a building can provide additional value by changing its load in various ways, and so that's laid out by these next three. So load shedding is the ability to reduce electricity use for a short period of time. Of course there's also load shifting, the ability to change the timing of the electricity use to either minimize demand during peak periods or take advantage of the cheapest electricity prices.

And then modulated one that's more of a _____ – you can see here the time scale is sub seconds to seconds, and this is really the ability to balance power supply or reactive power _____ supply in response to signals. And then, you know, the ability to reduce the overall load – shed, shift, and modulate comes from these various electrical loads and other energy assets that are inherently flexible I ability, and that would include things like batteries, and then in addition, ability may have onsite distributed generation such as PV, and in that case you would be able to generate as well, and then for your own consumption and in some cases dispatch. And so these sort of combined graphs at the bottom just represent the net load impact and sort of the teal is like we would be going for – if you wanted to have sort of a lower, flatter net load throughout the day, optimizing for the cheapest energy prices.

So if we go to the next slide this provides a little bit of detail, and I'm not gonna move through the – you know, discuss all of these. We actually have a report right now that lays out the different flexibility modes that can be provided by a GEB and some of the requirements. This is just to sort of provide a little bit of detail on each of these flexibility modes, you know, explaining with more detail the load change characteristics, the example measures, and then I think importantly here is just calling out that for different sort of products that the grid might need there might be different time requirements or the amount of change that is required and,

you know, these are gonna be really important, of course, from a building and operator's perspective to understand these requirements as well as the compensation needed for them, and so this is just a snapshot at that and the report that we could send out afterwards goes into much more detail sort of laying out some of these requirements.

So we can go to the next slide. Okay, great. And then, of course, the benefits of this. So we can discuss this a little bit more in our discussion, but this is at a very high level, just sort of looks across the board at demand flexibility. It shows that there's benefits at the utility system, the building occupants, which is what you're gonna be most interested in, and then society at large. So, you know, the owners can find savings and then to the controls there's increased choice, hopefully comfort, increased satisfaction, and then also this control enables environmental resiliency and DER integration options and the ability to make goals related to that.

So this was just a – I had about five minutes to run through some of the work that we're doing around grid-interactive efficient buildings, so this was at a very high level, sort of explaining the concepts as well as some of the benefits from demand flexibility, and I'd like just to close with a few slides explaining a little bit more about our work in this space and then, of course, we'll open it up for discussion at the end to get into more detail. So if you want to move to the next slide – great. So we really bucketed our work into four different areas. We have a good deal of work right now really looking at valuation, better understanding the value to different stakeholders, understanding sort of at-large opportunity space around demand flexibility. We also, of course, are looking at different technologies; which end use technology can provide different types of solutions to meet grid needs, which technologies are best at providing those needs, what is the impact on the equipment, et cetera.

And then moving to – back down to the bottom here, I discussed a little bit about the importance of control in this work and really the ability to optimize, and so we're looking both at optimizing within the building and then across a set of buildings as well. And then lastly really, you know, making sure that the technologies perform as predicted to meet occupant needs as well as grid needs, and we don't have a good deal of work in this space yet, but actually we released a request for information recently and that was some of the consistent feedback that we got, that this is a really high priority issue and more validation is needed in this space. So those are just – that was a quick summary of the way that we're thinking

about our research in this space, and if you want to move to the next slide, just I'm highlighting just a few projects here that we have.

I mentioned that we have an overview report that I can send out after the call. The overview report is actually a part of the technical report series that looks across all the different technologies that, you know, from HVAC to lighting to sensors and controls, et cetera, and evaluates how those different technologies can provide demand flexibility with the different flexibility modes I mentioned, that efficiency shedding, shifting, modulating. We also have another report series called the SEE Action series. That's our – we have a group here that are made up of state and local leaders, and so this report series is looking really at the value proposition, things like M&V, the more sort of a policy-oriented discussion, and those reports will be coming out a little bit later in the year.

We also are engaging with a number of stakeholders for feedback as we move forward on this work. So we have a utility working group that's actually focusing on commercial buildings, so I'd be happy to give an update on that in a future call. We also are working with NASEO-NARUC to have a working group hearing from state energy offices and regulators to see needs related to demand flexibility from their perspective and hope to be able to work with you in the future on this. And then I just highlighted a few of our research projects looking at, you know, our overall potential metrics, occupant comfort, and standardization are all really important aspects we're considering right now.

And so our last slide before I end is just a list of questions which I know we don't have time for now, so we can hopefully cover some of these at the end. Love to hear your feedback and thoughts in this space, so with that I'll end. Thank you, Rois.

Rois Langner: Thank you so much, Monica. And again, as Monica said, we'll have a little bit more time to dive into these discussion questions at the end. So I've actually repeated this slide and we'll look at it after RMI talks. So, thanks. With that, due to time, let's keep moving forward. We have Cara Carmichael, Matt Jungclaus from Rocky Mountain Institute, and Kinga Porst Hydras from GSA.

Kinga Hydras: So this is Kinga Porst Hydras and I'll start us off by talking about how GSA engaged in this study with the Rocky Mountain Institute, so next slide, next slide. So GSA is the landlord of the Federal Government, housing over one million federal workers focusing on their own mission, which is rarely operating buildings. So that's

why US GSA is fast with providing safe, productive environments for federal agencies. Next slide will give you an idea about the size of our portfolio, almost 9,000 owned and leased assets we're talking about, mostly office buildings in downtown areas.

So how did the focus on grid-integrated buildings come about? We have been really pushing the envelope and trying to achieve deeper energy savings in our building renovations and we have been partnering with the Rocky Mountain Institute and that program as well and we have been really successful in getting to 40, 50 percent, even 60 in one case, and in several places net zero facilities with the focus on a whole building analysis integrated design, looking at the entire building system and how systems work together, optimizing performance. We have been able to achieve these much larger energy cost savings. We looked around and we saw the work that the DOE Building Technology Office has been doing on technology and research focus and building on what Monica and her team is working on and also several other – the New Building Institute, for example, the Grid-Optimal Initiative is focusing on the rating systems and communities, but we really wanted to take a look at the GSA portfolio and see how it would make sense for us.

So we focused on building the business case around the grid-integrated efficient buildings. The technologies that are out there, we looked at the GSA portfolio across several regions and tried to prioritize areas where we can achieve buildings that are resilient, smart and flexible, taking advantage of demand response, load shedding, load shifting, and it was explained earlier. So I'm gonna move on and give the mic to Cara and Matt to talk about the results. One more thing, the report, we will make it public in the next few weeks. We are working with the DOE Building Technology Office, the peer review next week, so stay tuned. I think with the help of DOE we'll be able to get access to the reports in the coming weeks.

Matt Jungclaus: Great. Thanks, Kinga. This is Matt Jungclaus from Rocky Mountain Institute. I thought that was a really nice way to set up our study, and so I'm going to give you an overview of kind of what the inputs of our study were, what some of the assumptions are that we made, and how we designed our analysis, and then Cara Carmichael from RMI will talk a bit more about the conclusions and the results, a bit of a sneak peak to the report which will have a lot more detail to all of this. So hitting the overall context and purpose, I think that Kinga described the purpose of the study very well. You know, we want to look at a lot

of these measures that are more demand-focused rather than focused only on reducing energy consumption. So in order to do that, as Kinga mentioned, we looked at a few different locations.

You know, in order to be more representative of the GSA portfolio we tried to identify locations that would show more of a variety of opportunity for grid-integrated buildings measures as opposed to trying to represent every single utility regulatory structure. We're only focusing on the good ones so that we could really confirm some of our suspicions, but more than anything identify some of the best places to invest in grid-integrated buildings measures. This report as well, although it was designed based on the GSA's portfolio, we're hoping to build a larger fact base for building owners everywhere who could look at the opportunity for grid-integrated building measures in their own portfolios, largely focusing on commercial office, which was what we looked at in this study. Next slide.

So this slide really gives you the detail on what the inputs were to our model and what some of the outputs were to fuel our conclusions. So as I mentioned, we chose locations based on variety rather than trying to choose the absolute best opportunities, so the represent a variety of climate zones, rate structures, and something that's representative of GSA's portfolio which is pretty representative of all of the geographies in the United States and even beyond that. We'll talk a bit more about rate structures in a few slides, but we looked at 29 measures, some of which were modeled very specifically. Some others had to be modeled in a more custom one-off kind of way because a lot of the modeling tools available to us today don't look in as much detail as we'd like at demand, which again was the focus of the study and the measures.

We used localized labor and material costs. We looked at both all-electric and electric/natural gas combined buildings, looked at a variety of utility rate structures, and we also considered the value of demand response as well as just typical demand management. This information went into a modified version of the DOE reference model for a large office building, which we found to be similar in usage and typology to GSA's portfolio, and that output – a number of metrics on the right related to economics, energy, demand reduction, and that fueled some greater patterns and conclusions to give us an idea of the whole GSA portfolio but which we also think will inform other building owners. Next slide.

So we see three main values coming from grid-integrated efficient buildings. The direct benefits, you know, are probably the most important as we work with portfolio owners to understand these benefits, because these are how you pay for the measures. You know, where many of us are familiar with performance contracts or other ways to look at the economics, payback value, net present value, and those inputs are really what we were looking at in terms of direct benefits. So what are the portfolio-wide annual cost savings potential for the GSA? What does the payback look like on a per-building, per-project level in each of the six locations we modeled? And then it's important to note that even though rate structures will change over time these GEB measures, by providing flexibility, will accommodate future changes to rate structures, though it may not be the exact stellar figure we're predicting based on today's rates.

There's also a great amount of societal value, and what that really means is benefit not only to the portfolio owner, in this case GSA, but also to the entire grid, which should reduce utility rates for all grid users, including taxpayers who are important as federal agencies in particular make investments. And, you know, a lot of these savings we expect because grid-integrated efficient buildings measures allow the grid to reduce its investment in transmission and distribution infrastructure and generation costs. There's a large number of indirect values – next slide, please – and those include a lot of these pieces mentioned here.

Resilience is very important to the federal government, leadership both in the federal government and the commercial real estate industry, an expansion of public/private partnerships like ESPCs or energy savings performance contracts, transformation of the industry, better control over buildings, which usually leads to better quality and productivity inside, and then for others it might be carbon savings, it might be larger, you know, energy savings performance contracts and improved project value, because a lot of the measures that we looked at turned out to have quick paybacks and high net present values. Next slide, please. The measures we looked at fell into four categories. Traditional efficiency, which is essentially a constant reduction in demand throughout the operating hours of those appliances and they generally result in dollar per kWh savings.

Peak-focused reductions, which is – was really important for the GEB's essence of this report, so ECMs that focus on building peaks like heating and cooling ECMs as heating or cooling could drive a building's peak. More dynamic demand shifting, which we

consider to be load flexibility. Battery storage is a great example as you can shift loads from any point in the day to another point in the day, and demand response and distribution-level grade services. Next slide, please. I won't dig into too much detail on every single measure that we looked at, but I think the key takeaways – you know, you'll all be able to look at these slides.

You can see that we covered all four of these categories in various ways. We looked at lighting, heating and cooling. Next slide, please. We've also ventilation, plug loads, renewables and storage in a variety of ways. Some of these measures are pretty – they're fairly common and things that you would recognize, such as LED fixture upgrades, but we looked to add that extra GEBs element by doing things like, you know, control to do dimming during, you know, peak events or for a demand response. And again, we really looked to focus on these demand reduction measures, but despite that we were still able to achieve up to about 40 percent energy savings in the locations that we looked at. Next slide, please.

And this deck also has deeper detail on the variety of utility rate structures that we included. I won't detail this, but in short, you know, we found that the best returns were – no surprise – in locations with high demand charges, time of use rates, and seasonal variation and rates, and we anticipate that structures everywhere are trending in that direction, which only benefits the value of GEBs, but if you're interested please dig in deeper to this slide and, you know, you can understand better why the economics were favorable in locations like New York and California as opposed to locations like Georgia that had no demand charge. Next slide, please. And I believe at this point I'll hand it over to Cara to talk about our findings.

Cara Carmichael: Great. Great, thanks. So what we found, and as Matt iterated, there's a series of adoptable measures that we found, and it's not necessarily that these are innovative technologies in themselves but it's really how they were applied in our buildings, and I think it's really a paradigm shift that we're facing now, and we've gotten as building owners and practitioners and occupants, we've gotten really good at identifying energy savings and renewable energy opportunities in our building but we're less good at really thinking about and managing to demand, and so I think we're – what we've found is that, yes, there is significant value to building owners to also consider that fact when they're operating the buildings. So there's a series of adoptable measures, you know, several controls-based opportunities around HVAC, lighting, plug loads, also

incorporating renewable energy ad storage measures that define the cost-optimal strategy.

And what our initial findings are showing is that there's significant economic opportunities if you're incorporating grid-interactive efficient building strategies. So each location we were able to tailor a set of ECMs that provided a sub-4 year payback, and if those were applied to the whole portfolio of GSA buildings we found that we could reduce GSA's annual energy costs by about a third. This is a fairly significant savings, and it was really exciting to kind of think through how and what that would look like. And so the energy impacts of these measures really were enabling building energy consumption to be reduced by 40 percent and reducing peak demand by up to 80 percent, and I would say that this – you know, echoing Matt's thoughts – this analysis really was focusing on whether – you know what is the order of magnitude of this demand value to building owners?

And I think there's some tailoring that could be beneficial to look at it at a site-by-site level and really doubling down on efficiency as well as demand opportunities, demand management opportunities. So GEB's efforts will continue to deliver savings and it will even become more cost-effective as more and more utilities trend towards time of use and demand rate structure, so this is not something that is gonna get worse in the future. We anticipate it getting more cost-effective in more locations and we see GEBs as a key future proofing – it will provide cost defenses as utility rate structures change. So for GSA, and I think the takeaway for other building owners as well, is that a GEBs strategy should focus on fully controlling loads, really control systems, and as Monica laid out kind of that integration with the utility and the interactivity of different systems with one another so you can actually stage large building loads so that everything doesn't come on at one time driving peak demand, but you can turn different equipment on at different times so that really there isn't significant impact to how the building is operated.

It's just a little bit more intelligence as to when those loads come on. We found that year-round demand management delivers greater value than, you know, surgical demand response in most scenarios, so it benefits to keep a continual pulse on where your demand is, and we found that battery storage and solar PV actually makes sense in the majority of the six locations that we looked at today, and we think as these – as costs drop for these technologies they'll be more important in the future. Next slide, please. So I wanted to share just two specific examples of load shapes in the

areas that we looked at, and so this is an example of – the black line is kind of the typical baseline building and the blue line below it is an optimized scenario for the building in Phoenix, and what it was showing is that, you know, not only can we receive a 13 percent reduction in consumption, and this would likely be higher with a little more intentional focus in this area, but we can reduce peak demand by 19 percent and actually shift the peak of the building seven hours, and so that could provide significant value to the utility that's not capitalized today in the current rate structure, but we anticipate as these conversations become more commonplace and more – capture more traction that it will – some of that value will start to loop back. Next slide, please. Next slide, please.

Thank you – thank you. So this is a similar example of New York where we are able to show a more significant – a 32 percent reduction in peak demand and actually shift the peak from 5:00 PM later in the day to 8:00 PM, which could provide value to utility as well. And I will note that in this analysis we didn't factor in the impacts of EV charging. It's just not a big factor in GSA's portfolio right now, but I think that will be a big driver and a huge opportunity for commercial building portfolios since that is a load that we're getting a little bit better at modulating. Next slide, please. So I think what this – you know, diving in a specific example, what we found was that GEBs can provide significantly more value to a utility compared with today's demand response programs, and this can happen while providing profit to building owners, so it's a win-win scenario that we've outlined.

Next slide, please. So I think there are two levels of next steps that we came away with from this analysis, kind of immediately we recommended investing in grid-interactive efficient building measures in all electric buildings. Those showed more – obviously more opportunity to shift loads and as well as buildings with high demand charges and buildings with high baseline energy consumption and demand charge scenarios. So if you have those elements in your portfolio, those building attributes in your portfolio, start there. And then I think across the board and what we're seeing is we just – we have a great need for more pilot projects, and this is something that obviously, you know, Monica and BTO and NREL and our – we're all looking to foster more project examples so that we can point to and say this is how to do it right, and I think there's a difference between truly integrated grid-interactive efficient buildings and buildings that participate in demand response programs independently, and I think it's that

holistic integration of not only efficiency and demand response and smart technologies and control.

So I think one of the questions we'd like to talk through the audience with is what opportunities are you seeing, but next slide. So to determine longer term value, you know, we recommend starting to engage with utilities, and I think these are newer conversations that we're experiencing, and just being able to provide this is how much value my building can offer you as a utility, what value – you know, how can we start to close that loop on the value and track it both two ways I think is gonna be coming – it's gonna become more commonplace to have those conversations with utilities. I think another key finding is that we're fairly conversant as an industry on talking about energy use intensity and our consumption; we're must less affluent in talking about peak demand and we don't really track that as well in our buildings, and so starting to think about the metrics behind peak demand and becoming more aware of the peak demand of your buildings in your portfolio is I think another important next step.

Next slide, please. Thank you to several people who weighed in on our study and – next slide, please. We put together a few additional resources and you can search these links as the slides are sent out, and I think GSA and – you know, I think the folks on this call, BTO, they've kind of, you know, from our advantage point are showing real leadership in the industry and I think they can be a host of resources if you're interested in additional information. Next slide, please. Alright. Thank you so much.

Rois Langner: Great. Thank you so much Cara and Matt and Kinga for a great presentation. We're now gonna move on to our comments and questions section and I'm going to invite Cedar Blazek and Amy _____ to help with this. Cedar is going to lead the Q&A question. Cedar, do you want to take it away? And we do have a couple questions that RMI has come up with for discussion as well as Monica that we saw previously on the slide, so we can – maybe we should start into the questions from the audience first and then go into the discussions questions.

Cedar Blazek: Yeah, Rois. That sounds great. So we did have one question from the audience, and if you have questions or even comments right now please feel free to type them in to the chat box, or if you'd like to raise your hand we'd love to actually get a discussion going. As Rois mentioned earlier, if you do raise your hand we can unmute you but you'll get an audio PIN that you're gonna have to type in, so be on the lookout for that if you do want to speak, but we really

invite you to participate. We did have one question come in during the presentation. Are there DOE grants and/or utility rebates available to consumers interested in installing storage to help manage utility peak demand charges?

So the one – the best resource that I know of is the Database of State Incentives for Renewables and Efficiency, DSIRE. If you go to DSIREUSA.org you can search by your state and see what sort of incentives are available, but I did want to see if any of the other presenters had additional resources or thoughts on that question.

Matt Jungclaus: Yeah, this is Matt from RMI. Yeah, just really quick, I agree, Cedar, that the DSIRE Database is one of the best places. That's where we started. But to give a little color from our analysis, I think that California and New York were the two best states – no surprise there – for storage incentives, but I will also note that, you know, Cara mentioned that battery storage penciled in most of our locations for peak shaving, and where there were not specific incentives that was only driven by, you know, performing peak shaving at various intervals that would only change the monthly peak billing demand, so a lot of utilities that had demand charges that were at least moderate if not higher that made economic sense. So I would just also point out that a little bit of storage might pencil with no incentives at all.

Cedar Blazek: Great. Thanks, Matt. So this next question I believe is best answered probably for Matt or Cara, but maybe Monica can jump in. Can you expand on how the resiliency benefits of energy storage can support these projects?

Matt Jungclaus: Yeah, this is Matt. I can get started here. Yeah, so I think that the way resiliency plays into this is really interesting because resiliency is usually a piece of a project that people are less willing to invest direct money in but is a great benefit of projects that make economic sense, and if a facility has significant uptime requirements they might consider investing additional money in resiliency. So from our perspective there are a few ways to think about this. One is directly through things like energy storage, which can take the place of things like diesel generators or other, you know, onsite generation, like continuous heat and power.

You know, electrification is a large discussion in the industry right now and I think that batteries more and more can, you know, take the charge – no pun intended – to, you know, make up for the needs that were previously being served by fossil fuels. I also think that efficiency plays a huge role in this because you can really

undersize – or not undersize but right size your equipment, install smaller batteries, spend less money if you're able to manage load more first, and so that's not just with efficiency but also this load reduction.

Cara Carmichael: I would add that being able to stage your loads and have finer control over your loads can enable a site or a building or a base to reduce the onsite peak generation that they have, so it could enable less onsite generation requirements if we can have smarter buildings and can manage that peak load a little bit better.

Matt Jungclaus: Yeah. And then if a facility is already making investments in resilience and putting in a battery you can derive other values from that battery outside of just resilience, so it goes both ways, that a GEBs project can support resilience goals in ways that Cara and I spoke about, but a resilience project can also monetize battery storage that's installed to reduce monthly peak billing, participate in demand response or participate in other grid services.

Cedar Blazek: Great. Thank you both. Rois, do you want to go to the next slide with some of our questions and we'll see if we – we have some questions sort of to throw out to the audience and the folks that are on the line. We'll see if can get a little bit of a discussion going.

Rois Langner: Sure, let's start with the questions that Monica had mentioned earlier.

Cedar Blazek: Great. So we'll take answers to either of these questions if you want to participate or give us some feedback. How do you currently approach your energy efficiency demand response load management and interconnectivity efforts? Are you approaching them? What's the strategy? And what are the key barriers to the adoption of advanced controls that enable the ability to provide grid services? So two very different questions, but if you have thoughts on either of these go ahead and raise your hand. I'll go quiet for a minute and see if we get anyone who wants to participate.

Okay, well as you all think deeply about your answers to those questions, I do have another question for our panelists, so I'll jump into that one. So for the GSA study, did you consider or include the potential of generation onsite such as combined heat and power, CHP, and is more of this emerging?

Matt Jungclaus: Yeah, this is Matt. We did not look at CHP. We did look at solar as an onsite generation option, but the majority of our study was

focused on, you know, pure demand reduction efficiency measures, you know, looking at the building systems more than anything. We added solar and storage because storage is one of the most straightforward ways to add flexibility and onsite solar we feel is a great complement to storage. So no, we didn't look directly at CHP or some of those other generation sources.

Cara Carmichael: I think CHP could be a beneficial measure to look at for grid interactivity opportunities, but I think, you know, it's efficiency and using the equipment that's already in the building is obviously the most cost-effective first step and obviously CHP has kind of limited applicability in terms of office spaces.

Monica Neukomm: Yeah, this is Monica. I would just note that in our GEB work we do look across all sort of generation options. Of course, the cost-effectiveness is consideration as well, so CHP would be included – is an included aspect that we're looking at, and then of course we were looking just beyond, you know, an individual building but a set of buildings and optimizing _____, and so then like a microgrid there's even more of a play there.

Cedar Blazek: Great. Thanks, everyone. Rois, will you skip forward to the next set of questions quickly? Great. So here's a couple other questions we'd love to hear from you, and one thing I will say is that if you don't speak up and answer them now but you'd be willing to speak with us about these questions or maybe we could follow up either by email or by phone, we would love to hear from you. So, definitely reach out to us. We'll follow up with an email to everyone on this webinar afterwards. So the two other questions we have are what information would you need to make decisions about incorporation – about incorporation grid-interactive strategies into your portfolio and are you seeing examples of grid-interactive efficient buildings today?

Does that involve truly dynamic participation going beyond just traditional demand response program participation? Do you have any in your portfolio? Have you seen any examples and what gets you excited about them? So I do have a couple comments to share that I'm gonna read out loud. So the city of Chattanooga wrote in and said they're using BAS, doing major LED retrofits, and participation in demand side management with their municipal utility, and they're also investing capital in sub utility-scale solar, three megawatt systems it looks like, but additional analytics would benefit the city in pairing distributed renewables with key facilities.

So for them it's really about city and community level opportunities, which I think is really promising, the fact that the city of Chattanooga is thinking about it. So if there are any other city folks on the line who feel the same, think differently, absolutely let us know, but thanks for sharing that. Okay, we have another question for our presenters. Did the study look at thermal storage options or just battery storage? It seems like thermal could be relevant for owners with CHP or façade retrofits.

Matt Jungclaus: Yeah, this is Matt again with RMI. So the study did look at a limited number of thermal storage options, largely, you know, chilled water and ice storage, and what we often found was that, you know, for the sake of peak saving, battery storage was typically more economical and more flexible because it could provide other benefits. Also, thermal storage provided fewer benefits when combined with a slight temperature setback. We assume it's just a two-degree setback. So we did look at it and we were surprised to see that it did not pencil in many locations as well as battery storage, 'cause like the person asking the question I'm sure we thought that would be a homerun.

Monica Neukomm: And this is Monica again. I'll just note that this is something that we are definitely looking at, at BTO. This is in our technical report that I mentioned. This is cover under our building envelope report and we're looking at a number of technologies. I will note here though that more – some of these I would call more of like emerging sort of technologies, so we're looking at more of grid-interactive thermal storage options in the future in those reports maybe than existing technologies today.

Matt Jungclaus: Yeah, and Monica, I just remembered a relevant detail to that and to the original question, just that in a lot of cases thermal storage will make much more sense either for new construction or when you're already replacing a chiller or otherwise cooling system. I remembered a very specific detail from the study was that, you know, often it required retrofit or replacement of the chiller or installing a dedicated ice chiller, which significantly added to the upfront costs, and that was part of the reason why it didn't pencil. Logically, you know, thermal storage is cheap, but the equipment to store that thermal energy can cost a great deal.

Cedar Blazek: Great. Thank you both. Okay, so I think – ooh, we have one last question. Will RMI share measures in the final report? And I think as Kinga noted, they do plan to make the report publicly available. Kinga, is that correct?

Kinga Hydras: That is correct.

Cedar Blazek: Great. Yes. And so that will be published and you'll be able to access it and see what those measures and what the outcomes were. So I think it's just about time to wrap things up. One thing I will note, if this topic is exciting to you, if this is something you're interested in, something you're working on, maybe you want to host a pilot project in one of your buildings, maybe you're doing some of this work, we would love to hear about it, we'd love to know about it.

We're looking at building out a smaller stakeholder group and having more of these intensive discussions around this topic, so if you're interested in joining that please let us know. You can reach out to Rois. Her email is up here. Rois, I'll hand it over to you to close things out.

Rois Langner: Great. Thanks, Cedar, and a big thank you to all of our panelists today and thanks to everybody who called in today as well. Your feedback and questions were great. Again, if you have any additional comments or feedback for us, feel free to email me directly, or if you'd like to be added to our listserv and you're not currently on that please let me know too. We'd be happy to include you. After this call I will be sending out a followup email that will include a link to the slides and the recording of this call as well as some additional links to the reports or reports that were mentioned by our panelists.

Okay. Thanks, everybody. We're at the top of the hour and look forward to having you guys on future calls. Thank you so much.

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