Rois Langner: Great. Hi, everyone. Welcome to our call today. I'm just gonna wait one more minute before we actually start here. Thank you.

All right. Welcome, everyone. It's the top of the hour. I'm gonna go ahead and get started 'cause we have quite a bit of content to cover today. Welcome to today's Better Buildings Alliance Renewables Integration Technical team call.

I'm Rois Langner, from the National Renewable Energy Laboratory. I'm the technical lead for this Better Buildings team. Today, we have a really great call today. I'm excited about our speaker, Sheldon Mendonca, from RMI, and he will be talking about the potential for cost-effective decarbonization. Next slide.

So, for anyone new to these calls, the Better Buildings Alliance serves as a platform for commercial building owners, managers, and industry partners to share and deploy innovative, cost-effective, and energy saving solutions, as well as connect to technical experts on particular topics around building energy. Next slide.

The Renewables Integration Team – as part of our goals – we've historically looked at the strategic integration of renewables and commercial buildings, but lately, we've really shifted more towards looking at building load flexibility and grid coordination. And from the National Lab and engaging with other subject matter experts, we aim to really provide good resources, information, and guidance on these topics to building owners and managers. Next slide.

Today's agenda – I'm gonna run through some real quick announcements from my end, and then, I'm going to hand it over to our technical presenter, Sheldon Mendonca. He's the manager of Carbon-Free Buildings at RMI, and then, we will save about at least 10 minutes – hopefully, a little bit more – for some discussion and Q&A at the end. If you have questions throughout, please, use the Q&A panel. The chat function is disabled, but the Q&A panel is available for you to write your questions in, and we'll keep track of those. Next slide.

And again, just so you have our information here, I'm Rois Langner from the Commercial Buildings Research Group at NREL. I've been leading the Renewables Integration team for a number of years now. My partner in crime is Joyce McLaren, also from NREL. She's in our Integrated Application Center. She's the

co-lead also on this call and she'll be helping us with Q&A at the end of the call.

So, now, jumping to some announcements – you can actually skip two slides forward here. We are really pleased to announce registration for the in-person 2022 Better Buildings, Better Plants Summit. The registration is now open. It's going to be held in Arlington, Virginia from May 17th to 19th, and we have a number of really engaging and interactive sessions lined up, and attendees can also look forward to opportunities to network with their fellow industry peers and experts. So, go to the website.

These slides will be posted to the Better Buildings Solution Center about a week after this call so, you'll have all these links. The registration is open. There's a detailed agenda at a glance is already up. There are – there's a link to a hotel room block that closes May 2nd. So, check the website out for more information and we hope you all can attend. Next slide.

I like to always remind everyone that DOE has a great website – that it holds a repository of information around grid-interactive efficient buildings. I like to call it the "DOE GEB site" and if you Google "DOE and GEB" this website should come right up. So, if you're curious what has come out, what's been published on GEBs, please, go to this website. It's a great resource. Next slide.

And, in addition, our Renewables Integration Team also has a lot of resources that we curated on there. We have a number of featured solutions that we've more recently revamped. So, check out our website as well for resources around GEBs. Next slide.

And if you've missed any past webinars – just to mention that Better Buildings has a website for their on-demand Better Buildings webinars. So, you can go through and see all the past webinars that we've done on renewables integration topics here. There's recordings of the webinars, and links to the Power Point slides as well. Next slide.

A few new publications I wanted to highlight. NREL and Guidehouse work together to develop this new report that was more recently published called *Incentive Mechanisms for Demand Flexible Buildings.* This really highlights the incentive mechanisms that utilities and policy makers could use to encourage demand flexibility as a grid asset and capture this value. It also provides building owners an understanding of financial motives and

technical considerations to support the implementation of demand flexible operational plans and agreements. We did do a webinar on this a couple of months ago so, there's a link to the Better Buildings on-demand webinars site for that particular webinar that we did as well if you missed it. Next slide.

So, another publication I wanted to highlight is NREL did a blueprint for integrating GEB technologies into GSA performance contracts. So, this report really provides guidance to building operators on how to integrate GEB technologies into building renovation and improvement projects, particularly using federal energy savings performance contracts. But I do think there's a lot of overlap in what can be done in the private sector as well. So, it's a great report. I encourage everybody to go read through it. And next slide.

This is my last update here. So, the new publication we are talking today about is this RMI study to assess the value potential for GEBs in a big box retail portfolio. The predecessor to this study was a study that we did a webinar on – maybe a year and a half ago now – on the value potential for grid-interactive efficient buildings in the GSA portfolio. So, we're slowing growing these studies to look at different portfolios of buildings. So, now, we have the retail sector, which we will be talking about today, and – coming soon – we will also have a third report in this series that's focused on multi-family, which we're really excited about.

So, with that, let's skip forward to our technical presentation. You can skip two slides forward, actually.

Again, our presenter today is Sheldon Mendonca. He's a manager with RMI's building practice where he's working with a team to build an in-house analytical tool called Portfolio Energy Optimization, that evaluates large portfolios of buildings for deep energy retrofits across North America while optimizing around investment thresholds, carbon emissions, utility rates, weather zones, and end-use cases. Sheldon, we're really excited to have your here today and I, personally, am really looking forward to this – to your talk and presentation. So, welcome, Sheldon.

Sheldon Mendonca: Thank you, Rois, and thank you, everyone. Welcome to this presentation. Thank you for taking the time to sit with us through this presentation. My name is Sheldon Mendonca. I'm a manager within the Carbon-Free Buildings practice at RMI.

I work with the Portfolio Energy Optimization Team. So, essentially, our mandate within Portfolio Energy Optimization is we engage clients with large portfolios of buildings. Some own and manage hundreds – even thousands of buildings – and this study with the retail portfolio is essentially looking at around 1,200 stores across the US. Next slide.

So, we'll be looking at today cost-effective grid-interactive efficient buildings, and the decarbonization potential for the broader retail sector. Our findings are focused on a particular portfolio, but we've also come up with a larger – a broader retail sector findings. Next slide.

We have quite a bit to get through, so, hopefully, I can do justice to most of these slides here. We'll look at the project overview to give you context on the scope of work and the goals of the project. We'll look at some of the key findings at a high level, at a portfolio level, and then, we'll drill down a little bit into demand profiles – for example, stores – and how our solutions sets impact demand profiles on the ground. Next slide.

So, essentially, when we started this study for the retail portfolio, our goal was to provide actionable solutions through a specific portfolio so that they can have an investment plan going forward. We also wanted to inform the emerging national conversation around demand flexibility, and hopefully, using this report in our findings, we wanted to scale successes – the success story – for the retail portfolio to the broader retail sector – and this is most specifically the strip mall style retail stores. Next slide.

What is a grid-interactive efficient building? Some of you here might know what it is, but I'd like to go over the key concepts. So, the main building blocks for a grid-interactive efficient building is energy efficiency, distributed energy generation, smart controls, and energy storage. When these four building blocks are co-optimized continuously to minimize energy costs, provide grid services, and improve occupant comfort, that's when we have a well-performing GEBs building. So, just keep in mind these four building blocks, because most of our solutions – our measure packages actually fall within one of these four building blocks. Next slide.

We also looked at how to decarbonize specifically BBRN Member ACEEE portfolio, and what you would see here is that the building blocks for a GEBs building is actually very similar to that of a

decarbonized building. So, essentially, the first three blocks that inform solutions for a GEBs building actually enable us to electrify or decarbonize a specific building or a portfolio. So, our solution sets actually look not only at making this portfolio grid-interactive and efficient, but also, looking at cost-effective solutions for decarbonization. Next slide.

So, this is a portfolio overview. On the left, you see a map where the stores are located. The stores were located – we selected from around 1,200 stores. We selected the Own portfolio, which is about 500 stores, and then, we drill down to about 113 that are actually are representative of the entire Own portfolio of retail stores. We selected about 113 stores across 43 states and 7 climate zones.

What we realized – that these stores are extremely efficient. They have an average portfolio managing Energy Star score of about 94, which means that they were better than 94 percent of the strip malls in the US. 29 stores had demand response already. All of the stores had monthly – or yearly demand management strategies implemented. 21 stores had rooftop solar arrays and the size of the stores were about 64,000 square feet to about 100,000 square feet.

Using these 113 stores with a built-up space of about 9.5 million square feet, we applied 60 plus relevant measures to these stores, which, in the end, resulted in over 4,500 energy simulations that we had to post-process and come up with an investment plan for the entire portfolio. So, it's essentially a pretty large project over an entire year that our team was engaged with, and we're really proud to present these results. Next slide.

What is PEO? So, Portfolio Energy Optimization is a software solution that has been built in-house at RMI over the last five to six years. Essentially, we can use a mass customized approach to energy modeling, which means that we can model hundreds of buildings at a time. Our largest portfolio that we model is about 13 million square feet for the Canadian federal government. This is about nine million square feet. We got the data.

The funnel on the left-hand side actually represents data collection. We gather data on energy systems – that's the HVAC information, lighting, loads, information schedules. We also build the energy model from ground up – meaning that we have geometry information from satellite images and drawings, carbon emissions and targets, all built into every single model, and this specific to the location. We then produced energy models that are [inaudible]

and quality controlled, apply individual measures to each of those buildings. Using the individual measures and investment thresholds the client has given us, we come up with ECM bundles – that's Energy Conservation bundles – or measure packages you may call them.

And then, we bundle that up to an entire portfolio and come up with then a portfolio-wide investment plan, which we'll get into in the next slide. Next slide, please.

So, looking at the entire scope of the project, we looked at about 13 measures, and about 60 plus variations. Each of these measures have variations in terms of financial variations, as well as energy variations. Say, for example, a battery measure can either maximize kilowatt savings or it can maximize to IRR – that's Internal Rate of Return. So, financial savings and the sizing of the battery is actually determined by this choice. Each of these measures have different variations.

Remember I spoke about the four building blocks of demand flexibility, efficiency, electrification, and renewable energy? That's essentially where our measures landed as well. Next slide.

Now, we get into some of the key findings. These are portfolio-level findings that once we apply measures for every single building, we sort of wrap this up into a portfolio-level investment plan. So, next slide.

There's a lot of content here, but first, I'd like to focus on the graph on the right. What we did was we evaluated three different scenarios. One was a 10 percent IRR scenario. IRR is Internal Rate of Return. That's basically the rate of return – annual rate of return – that you would expect for an investment.

So, we looked at measures that had a 10 percent IRR scenario. We also looked at measures that had a six percent IRR. And then, we came up with a sort of a blended scenario where we looked at – we implemented heat pumps within a 10 percent IRR scenario and we made sure that the entire package, with the heat pump, matched the 10 percent IRR requirements. So, what did we find when we used all of these three scenarios and analyzed it? We can cut portfolio-wide energy cost by about 37 percent and reduce carbon emissions at the same time by 27 percent, with a 6 percent IRR, which is quite lucrative internal rate of return.

Lighting and rooftop updates were the biggest contributors – and we'd see that later – to the NPV or savings. The clients can shave off approximately 17 percent – or 5 megawatts offload – on an annual level, but if you drill down and look at this on a store by store or a monthly level, we can cut, for example, electrified stores, or stores with resistance heating can reduce peak demand by about 50 percent. And we'll look at one example later if we have time. About 19 stores – or 17 [percent of the stores – can get high-efficiency heat pump RTUs installed. That's in – combined with efficiency, demand flexibility, and rooftop solar measures.

These stores could be used – most of these stores are transitioning from electric businesses to heat pump, and these stores can be used as pilot projects to get experience with heat pumps. And demand flexibility – they were already doing really well with demand flexibility, but we found ways to improve upon their existing algorithms. And what we found was over 50 stores out of the 113 can have – 50 percent of the stores out of the 113 can have cost-effective demand management solutions. Next slide.

While looking at just a specific portfolio, we also wanted to look at what are the solutions that can apply to the entire retail sector as a whole? What we found was these top – you know, top line seven ECMs you may call them, or investment goals, what you can measure, you cannot control. And so, you know, this particular portfolio had a centralized enterprise level energy management system, which was really helpful. We also recommend that demand flexibility strategies – like, staging HVAC equipment, staging the compressor loads on HVAC equipment, for example, staging fans to avoid coincident peaks during high-demand periods – was very lucrative, and the control sequences should look for a monthly – should be adjusted monthly and not annually with respect to varying costs and carbon intensities. We also recommend that LED fixtures with integrated sensors be installed within each store.

Rooftop solar was very lucrative as well across the portfolio, and we recommend having – looking at electrification solutions like air-source heat pumps, high efficiency rooftop heat pumps as well, alongside efficiency – other efficiency demand flexibility, and renewable energy energy measures. Because there's a great synergy between these four sort of building blocks to decarbonize your building. Next slide.

So, looking at the six percent IRR scenario, what did we find? So, drilling in a little bit deeper, we found that over a period, there's a $23 million investment opportunity with an NPV potential of about $7.6 million, and a simple payback of about 7 years. We can reduce energy use on the electricity side by 16 percent, reduce peak demand – annual peak demand – and, like I said, this varies per store by about 16 percent, and reduce portfolio-wide emissions by 27 percent. Gas use increased because we transitioned 50 percent of the stores from conventional lighting to LED lighting. What this scenario shows is that it is cost effective to invest in grid-interactive efficient buildings, and there is a [inaudible] upside on the ability to reduce costs – utility costs – as well as reduce carbon from your portfolio.

And, as cities and state governments increasingly pass carbon emission targets, this scenario will have future-proof entire portfolios. Next slide.

What was really interesting – and we've seen this across – you know, over the last four or five years when we do portfolio-wide studies – is that different stores have different investment potentials. You can see, in the graph below, NPVs on the Y axis and the actual stores are on the X axis. The color codes are investment potential within measured categories. So, DHW, demand flex, envelope upgrades, lighting, HVAC, and solar PV. We can clearly see that solar, PV, and lighting, account for the vast majority of the NPV potential, and certain stores have much higher investment potential than others.

And so, what this does it helps to allocate capital to the most effective – or most cost-effective stores initially gain a lot more experience with these investments, and then, roll out a portfolio-wide investment plan – over 10 to 15 years. Another thing that we can also see here – and it doesn't show up in the graph – is demand flexibility measures actually pan out across a vast majority of the stores. Their NPV potential is small, because they are already implementing demand response and demand management within their portfolio, but we did find that 50 percent of the stores have demand flexibility potential with the 6 percent IRR scenario. Next slide.

The carbon reduction potential by measure type – and this was also interesting. You can see that solar, PV, and lighting, have some of the highest carbon reduction potential, but efficiency on the HVAC system, using heat pumps for DHW loads, have the second greatest

potential for reducing carbon, and then, demand flexibility offers about a two percent reduction in carbon on the existing grid. That increases as renewables gain momentum and have more of market share on the grid. Next slide.

The difference between 10 percent and a 6 percent IRR scenario – this is a really interesting slide, and it has a lot of content, but I'd like you to focus on the right 2 columns. So, essentially, when you do reduce investment thresholds or requirements for return, you can clearly see that the measures that pan out for a 10 percent IRR store increase for a 6 percent IRR store. So, for example, 60 stores had demand flexibility potential in a 10 percent IRR scenario. 63 stores had demand flexibility potential in the 6 percent IRR scenario. We can also see that some of the biggest moves happened with electrification – that's from eight stores that went to 11 stores.

In the targeted heat pump scenario – that's sort of a middle ground scenario – we can see that 19 stores have actually cost-effective heat pumps within that scenario, and that shows that heat pumps can be cost-effective and they need to be packaged with other efficiency, demand flexibility, and add rooftop solar measures. Renewable energy actually went from 19 stores to about 51 stores. So, that's close to 50 percent of the stores can meet their electricity demand with the 6 percent IRR rate of return essentially. That was one of the big findings that we found for this particular portfolio. Next slide.

This is a 10 percent IRR scenario, similar to the 6 percent IRR where there was a $20 million opportunity – $20 plus million opportunity. Here, we see there's a $12 million investment opportunity with a $5 million NPV, and a 5 years payback. Obviously, the payback is reduced here, because the internal rate of return is much higher. We see similar numbers for electricity and peak kilowatt shaving. There is a portfolio-wide CO_2 reduction of about 19 percent in this scenario, so, using a 10 percent IRR scenario – which is quite aggressive – we still found opportunities to reduce costs and reduce carbon emissions with a portfolio that has an Energy Star score of about 94.

So, with a [inaudible] efficient portfolio, we did find significant investment opportunities within this scenario. Next slide, please.

Similar to the six percent IRR scenario – I won't spend too much time here – but essentially, each store has a different investment potential. There are individual measures that work for certain

stores versus others, and certain stores have much larger investment potential compared to the right side of the graph. And we have asked the portfolio owner to focus on these stores to invest efficiency and demand flexibility measures. Rooftop solar and lighting upgrades account for about 80 percent of the NPV value within this scenario. Next slide, please.

Targeted heat pump scenario. So, this is interesting. I'd like to spend a little bit of time on this scenario. So, essentially, we wanted to look at how heat pumps pan out within these two scenarios. So, we applied heat pumps within a 10 percent scenario and then, looked at the entire package, whereas as the other two scenarios looked at individual measures that met the investment threshold of 10 percent or 6 percent.

We looked at the entire package with the heat pump and isolated those stores that actually beat a 10 percent IRR scenario. And we found a significant opportunity there as well. We found that 19 stores can be retrofitted with high-efficiency heat pump in combination with other measures. This scenario can reduce annual utility costs by about 28 percent, while abating 20 percent of the carbon emissions, and you know, we've seen, from the past momentum on carbon and focus on climate change, that about 24 states and territories have taken legislative action or executive action to move towards 100 percent clean energy future. This pathway helps portfolios sort of get ahead of that curve.

And one final thing is that in the 10 percent IRR scenario, we saw that 8 stores got high efficiency heat pump RTUs that went up to 11for the 6 percent IRR scenario. In this scenario, we have 19 stores that get cost-effective heat pumps along with other measures within a bundle. Next slide.

Impacts on demand profiles. I want to spend a little bit of time on how these measure packages impact demand profiles so, we'll get into two examples – one in New York and another, I believe, it's in Alabama – on how these different scenarios impacted demand profiles at an annual level, monthly level, as well as on a daily level. So, we'll look at those examples now. Next slide.

This is a sort of definition for what demand flexibility is. It's the ability to shift energy used based on carbon all cost signals. Why is it important? As the grid gets cleaner with more wind and solar, demand flexibility can enable high utilization of these variable

generations and provide a more resilient and carbon-free grid. Next slide.

So, let's take a look at – we've anonymized the stores so that we keep the store and portfolio anonymous. So, this is store 23. It's in New York, climate zone seven. The 10 percent IRR scenario has demand flex DHW heat pumps and rooftop solar. So, you can look at – the 10 percent IRR scenario is essentially the green.

Is that the green? Yes, it's the green bundle – green line on the graph. The six percent IRR scenario also adds heat pump RTUs, and so, you can see the impact in Jan and Feb on the yellow and blue line, because they both have electrified their loads from natural gas. So, at a high level, you can see that the winter loads are high. The winter peaks are high for the six percent and targeted heat pump scenario, but they're not much higher than the baseline, which is in black on the top.

As the electricity grid decarbonizes over the next decade, electrification of heating supports the overall building decarbonization over time. You can clearly see that battery storage, demand flex efficiency, and rooftop solar measures mitigate against high peaks when heating is electrified. So, without all of these other measures, what we have seen is that peak loads from heat pumps can go up to about two times the baseline peak load. And so, to mitigate against that, it has to be combined with efficiency and demand flex and solar rooftop measures. Next slide, please.

So, for this same store, same location, climate zone seven, we look at a summer day, and you can clearly see these three scenarios, how they shift peak from about 2:00-3:00 PM towards later in the evening. The summer peak demand is reduced by about 26 percent for this particular day for the targeted heat pump scenario, and about 17 percent for the 6 percent IRR scenario. So, you can clearly see that there's a reduction in demand, and also, a shifting of demand later in the day. The reason why these loads go negative early in the morning is because there's not much load in solar kicks in for each of these three scenarios. Next slide, please.

Looking at a winter day, for example, for these scenarios – and you can clearly see, you know, the monthly peaks in Jan and Feb actually happen on a winter day in the morning when the heat pumps kick in to pre-heat the space and to make sure that the loads are met before store operating hours. You can clearly see there's a

shift in peak from the baseline – the baseline is the dark color – the black color. It moves from midday, again, to early in the morning or later in the evening, depending on which scenario you look at, and each of these scenarios, you can see the solar kicking in and impacting midday loads – early morning and midday loads here. One thing to note here is that for a winter day, the peak demand is increased by 55 percent for the targeted heat pump scenario and about 72 for a 6 percent IRR scenario. But if you look at the entire year, the peak demand doesn't increase much compared to the summer peak of the baseline. Next slide, please.

And this is looking at the same store on a mild day, and this is, again, store 23, New York. You can clearly see there's a shift in peak from the midday to later in the day, and you can see solar kicking in early in the morning. The baseline peak is about 180. It's about a five percent reduction for all scenarios under [inaudible]. Next slide.

So, this is another source of [inaudible] Alabama, climate zone 2A. You can see this is an electrically heated store, which means that there's a resistance heater that comes on in the mornings during the cold days – few cold days – of the year. The peak demand is about 470 kilowatts in the baseline. That can be reduced dramatically by about 50 percent – over 50 percent – for all of the three scenarios, because each of the 3 scenarios get, in this case – for store 65 in Alabama, it gets a heat pump RTU, which means we are moving from electric resistance heating to heat pump RTUs. We also have solar rooftop in all of the three scenarios, so, that mitigates against the midday peak loads.

And the targeted heat pump scenario also gets battery storage and so, you can see some of the impacts of that in the blue line where battery storage kicks in during the operating hours and we look at daily load profiles as well. So, all of these three scenarios, for this particular store that's electrically heated using resistance heating, has a potential to not only reduce peaks throughout the year, but also shift peak during the day. Next slide, please.

This is demand profile comparison across scenarios for a summer day. You can clearly see that all of the three stores have much lower demand during the summer. Some of the loads actually go negative because of the solar and is [inaudible] here in this property. We made sure that the solar is right size, which means that it does not produce more energy over the entire year than the loads. So, a lot of these stores – about 50 percent of the stores for

the 6 percent IRR scenario – we found that solar rooftop can actually provide for the entire year's electricity consumption for that store – for 50 percent of the stores across the portfolio.

There's a small shift in peak during the time of peak so, it moves from about 2:00 PM to about 3:00 PM, but there's a significant reduction in peak load. It's about 22 percent for the 6 percent IRR scenario and about 23 percent for the targeted heat pump scenario. And I hope I'm not confusing you all with all of the different scenarios. I'm happy to go over them again. I know it can get a bit confusing during the Q&A. Next slide, please.

Here, we're looking at a demand profile comparison for a winter day. You can clearly see that the winter peaks are reduced dramatically during early morning hours, although, there is a hit on the grid, but it's not as high as an electric resistance heater coming on before store operating hours. We can clearly see, also, that the peak load has shifted to later in the evening when, you know, for certain measures – specifically for the targeted heat pump scenario – the battery's actually evening out the load during store operating hours. And you can clearly see that after the store operating hours, the battery starts to charge on the tail end of the graph and in the early morning or late-night hours on the left-hand side as well. Winter peak demand is reduced by about 42 percent for this particular day using a targeted heat pump scenario, and by about 38 percent or 39 percent for a 6 percent IRR scenario. Next slide.

And the same store in Alabama on a mild day. We can clearly see there's a shift in load from midday to later in the evening, and we can see a significant reduction in peak demand as well – about 10 percent for this day for the targeted heat pump scenario and 4.2 percent for the 6 percent scenario. Next slide, please.

Yeah. That's it for me. I hope this was informative and interesting for you. Feel free to chime in with any questions.

Rois Langner: Great. Thank you so much, Sheldon. Really interesting work and we've gotten a number of questions in the Q&A – just a reminder for people to write their questions in the Q&A. I know there was one hand that was up so, if you could just transition whatever question you have into that chat box, that'd be great. But I'll hand it over to Joyce to manage the questions here.

Joyce McLaren: Sure. Thanks, Rois – and thanks for that presentation, Sheldon. That was excellent. We do have a couple of questions – a few of

which we went ahead and answered in the chat – and I'll just go over those to point everybody to them. Someone asked about the slides – whether they will be available, and they will be posted on the on-demand Better Buildings webinar site in about a week's time. So, we do have a link that is posted, again, in the Q&A chat.

I think everyone can see it – let me know if not – but those will be posted for everybody to download. There was another question that we went ahead and answered about whether or not these stores were non-food retail or included food and refrigeration, and the answer is that it is non-food retail. So, that's why refrigeration was not one of the ECMs that we were looking at here. So, going on to the still open questions, we had one about the – well, there's one that was a little more complex about – I think it's about split incentives. And I wanted to go ahead and cover that one first.

And the question is around whether or not you are socializing these findings with real estate communities – especially in situations where there's a split incentive between the owner of the building and the tenant of the building who is actually paying the energy costs. And I was wondering if you wanted to comment at all on that sort of split incentive sort of issue where there's a different tenant.

Sheldon Mendonca: Sure. So, for this specific study, we looked at 500 odd owned stores, so, the client actually owned the portfolio and was paying the electricity and gas tariffs. With respect to the split incentive, that's a really interesting question, and I think, you know, with the multi-family report that's coming up, we will be looking at specifically the split incentive question where you do do an investment in say, the central system – how does that impact cost benefits, essentially? And what we're doing with that report is that we're looking at the paybacks for the owner side separately from the paybacks for the tenants. So, for this specific report, we didn't look at split incentive, but we will be looking at split incentive going forward. Hope that answers the question.

Joyce McLaren: Great. Thanks. Can you say more about the black roof membrane measure that you use? And would that vary depending on the climate region?

Sheldon Mendonca: Correct. So, we found that the black roof membrane only applies to really northern climates, and the white roof membrane sort of works out for the hotter climates, the southern climates. So, essentially, we applied black roof membranes to the entire

portfolio and white roof membranes to the entire portfolio and found that it doesn't apply Black roof membranes don't pan out. Basically, you know, there's not improved efficiency of the store in the southern climates.

Joyce McLaren: Great. Can you talk about the scheduling assumptions that you were using for the electric resistance and the rooftop units – the heat pump rooftop units – scenarios?

Sheldon Mendonca: Yeah. So, what was great about this portfolio was they had an enterprise level energy management system so, essentially, we could drill down, and we got a download of their schedules for lighting, for HVAC, down to individual RTUs. So, we could build out schedules specific to a certain store and a certain location. So, we actually got that data from the client; we just built those into our models.

Joyce McLaren: Okay. So, the continuation on that question was a comment about the solar. It looked like there was an additional opportunity to both utilize solar generation for heating and to spread the heating load across more nighttime hours. I don't know if you want to make further comment on that.

Sheldon Mendonca: Solar generation for heating. I'm not sure what that means –

Joyce McLaren: Maybe electric heating. Yeah. I don't know.

Sheldon Mendonca: Right. So, we looked at only rooftop solar PV. We didn't look at solar for – to generate heat, essentially. So, the rooftop PV just feeds into the electric meter during the day. So, what we had to do – and just to step back from that question – is what we have to do is we have to optimize for costs first, because we were working with a client that had very aggressive IRR requirements, and then, we had to optimize for efficiency and carbon reduction.

So, I think there's definite potential to improve solar generation on these stores, but we made sure that these stores were not over-producing over a period of year. Maybe it would over produce for a few days during winter or during mild climate days, but on an annual level, the solar generation actually needed to match electricity. The roof – most of these stores were single or two-story strip mall style stores and so, the had massive roofs. And if we actually maximized solar generation, we would be over-producing, and that would be a financial penalty to the client.

Joyce McLaren: Great. Thanks. A couple of questions about IRR. So, when you talk about IRR, do you mean that the savings over the cost of the investment on the equipment? How many years in general do you use when you calculate the IRR? And just how fast can the owner get their investment dollar back?

Sheldon Mendonca: So, that's essentially what it is. IRR is an annuitized return. So, if you make an investment of $100.00 and you want – and the equipment lasts for about 15 years, for example, for a heat pump RTU – or maybe more – every year, you need to have a return of about 12 percent – that's $12.00. That's what IRR means. So, every measure has to meet an IRR requirement of about 10 percent, or a 6 percent depending on the scenario we're looking at. Rois, I think you had something to –

Rois Langner: Yes. I do. So, I just wanted to follow-up to the heating and spreading that out. There's an additional comment here that the idea on that would be to schedule our heating stages during times when solar generation is occurring and to schedule more heating stages early in the morning as a preheating measure. I also have kind of similar thoughts about that when you were sharing the New York winter day scenario where heating is – was higher with the heat pumps in that store under the heat pump scenario.

So, I was thinking more about how do we further optimize when we're using the heat and bringing in batter storage to help offset some of those peaks that we're seeing now in the winter time, and evening out that load as next steps of thinking about GEB operation in these buildings.

Sheldon Mendonca: Right. And we did see there's a peak in the winter morning for electrical resistance heating because that's the baseline, and they were not optimizing. With our models, we tried to optimize for peak demands in the day time, and it's also mitigated by other measures. And battery measures, unfortunately, panned out in only about five stores, and we had one example there. But I think, you know, as battery costs go lower – and we've seen a cost reduction curve for solar and wind and battery as well over the last five years as battery costs go lower – I think batteries have become more of a solution combined with solar PV withing the GEB space.

Joyce McLaren: Great. Thank you, Sheldon.

Rois Langner: We have somebody asking if you're familiar with how many states have demand response and flexibility programs to be able to take advantage of some of these opportunities.

Sheldon Mendonca: Right. And you know, within this portfolio, about 29 stores had some sort of demand response. The problem with demand response is it's not at the state level; it's at a utility level. And it can get pretty complicated. Every year, utilities update their ask for demand response.

They update the revenue that's generated from demand response. So, it's a pretty complex space, and I don't know on the top of my head how many states or how many utilities have demand response programs. But quite a few of these states, you know – in the Northeast, for example – have demand response. And in California, where there's high demands – peak demands during the day – a lot of these states have demand response. We see less in the central of the country where there's not a lot of peak demand during the day.

Joyce McLaren: Great. Thanks. And a question about the model. Is the model that was used by RMI for the study – is it publicly available for the portfolio management?

Sheldon Mendonca: No. The models are not publicly available. We have a lot of sensitive information that's very specific to the client and so, we do not publish the models.

Joyce McLaren: Hm-hmm. Yeah. And I'll just reiterate this in another way in case I misinterpreted it. Are the models used for portfolio management publicly available? I don't know if that was – if the question was about energy portfolio management.

Sheldon Mendonca: Right. So, the tool is. So, right now, the tool is inside of a desktop version of the evolution of our software. We still have an in-house team that works with this tool. What we're trying to do is we're trying to scale the tool by maybe Q1 or Q2 2023.

We'll be launching this tool as a web-based application, and that's when this web-based application will be available for portfolio owners – building owners that have 1 – even 10 buildings – to sort of put in their information. We'll walk them through the analysis and come up with investment plan. So, maybe next year, if you keep an eye out, there's been a launch of PEO, with a new name, on using a web-based platform.

Joyce McLaren: That sounds like that'll be a great resource. Anybody else have questions?

Rois Langner: Sheldon, I'm –

Joyce McLaren: Oh. Go ahead.

Rois Langner: Thank you, Joyce, for saying that, but while we wait here, I just had one observation that maybe you can further comment on, and it really is along the lines that we have this pretty high-performing portfolio of retail buildings across the country, and yet, lighting is still a major key contributor to the cost-effectiveness and savings of these buildings. And I just think that's interesting since, at least from the National Lab and DOE perspective, we've done such a large push on lighting, and yet, that's still such an effective measure across these stores. So, I thought that was a really interesting finding from the study.

Sheldon Mendonca: I think that's really interesting and surprising as well. 50 percent of the stores had LED tube replacements – which means that they actually just went in and replaced the tube. So, for those stores, we didn't apply an LED measure, but for the rest of the 50 percent of the stores that we evaluated, they had traditional fluorescent lighting, which was quite surprising, for a highly efficient store. And we engaged with the portfolio owner point of contact there for any reason – a specific reason for that – and it was just that they do a store-by-store approach to these retrofits, and they don't look at it for the entire portfolio. So, similar with solar rooftop.

We just saw this portfolio was an early mover in the space initially and they have 21 stores with solar rooftop and they kind of just stalled because of other priorities. We must understand that a lot of these clients – they want to do the right thing, but the business environment or the economic environment actually dictates what they can and cannot do, because energy's not their core business.

Rois Langner: We have a couple more questions that are coming in. Did you find any difference between a fully regulated electricity markets versus the de-regulated markets when it came to the viability of these demand flex measures?

Sheldon Mendonca: Right. We looked at utility rates in depth, and we tried to find cause and effect for some of these measures. And what we found is that because we're – we have about 16,000 variables each week,

alongside just the target variables. So, the existing equipments – how they are run – impact measures as much as the utility targets. We did say that we have seven different utility types of tariffs there, but every store has their own nuance in terms of electricity tariffs and we didn't find a direct correlation.

We actually did a study where we didn't find a direct correlation between our measured packages and electricity tariffs. Our packages actually worked out economically across tariff zones.

Rois Langner: That's really interesting. A couple of questions about other building types – studying other building types. Are you gonna be working at all for larger commercial buildings that use chillers, for instance, or will you be applying the modeling to offices or industrial sites? And then, a question about multi-family – which I think the answer might be "Yes."

Sheldon Mendonca: Yes. Yes, to all of the above. So, if you look at some of the projects that we've done in the past – we did a project for the Canadian federal government in the National Capital Region. We model about 170 buildings that were mixed use. So, right from small warehouses and storage spaces that were 300 square feet to 2 million or 1.5 million square feet office spaces and multi- use spaces.

There, the analysis was a bit different – was focused on decarbonizing the portfolio, with a two percent discount rate. The federal government can get discounted financial packages. And so, our solution there was very different. Depends on the goals set by the client. So, we have done a portfolio study for the Canadian federal government. We also did a study with GSA on office buildings, and we're looking at multifamily next.

We actually – we're 70 percent of the way there on the multifamily portfolio for about 29 properties. It's, I think, around 7 million square feet covering about 4,000 or 5,000 residential units.

Rois Langner: And will the results of all of those studies be available from the RMI website? How would be the best way that people could understand the conclusion –

Sheldon Mendonca: If you just look for portfolio energy optimization, Rocky Mountain Institute, you should get our web page there. And, on the Resources page, I could just post it here as well. Just give me one second. Maybe I'll just do that here. But on the Resources page for

PEO, you should be able to get all of the reports and blogs we've written about this.

Rois Langner: Great. Thanks. And I'll just note that, in the chat, I did post the link to where the slides from this presentation will be posted on the Better Buildings website.

Sheldon Mendonca: Okay. Let me post this as well. And, at the bottom of this page, you should be able to get reports and a number of blogs we've written recently about this space.

Rois Langner: And, Sheldon, did you already comment on the GSA analysis and the types of equipments in those buildings?

Sheldon Mendonca: No. I haven't commented on that, and unfortunately, I was very peripherally involved in that study. But I'm happy to take any questions on the GSA, if I can, or if I can't answer the question, I am happy to respond by e-mail later.

Rois Langner: Yeah. And I did provide a link to the GSA report that RMI published earlier in the slide deck in the introduction slides.

Joyce McLaren: Great. Are there any other questions or any clarifications of questions we've already gone through? All right. Well, hearing none, I'll pass it back to Rois to close it out.

Rois Langner: Yeah. Well, thank you to everybody who joined today. Thank you to Sheldon for giving an excellent presentation.

We really appreciate all the questions. I think we actually left enough time for questions today, which is a success, in my book. If anything else comes up or you want to contact us, feel free to reach out to Joyce and myself. Our contact information is here at the end. We'd be happy to field additional questions or recommendations for future topics that we might have.

But, again, thank you all. We really appreciate your time today and thanks, once again, to Sheldon.

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