Rachel Shepherd: I think we're gonna go ahead and get started. Hello, everyone, and welcome to the 2020 Better Buildings, Better Plants Summit: A Virtual Leadership Symposium. I wish I could see all your lovely faces today in person, but I'm glad you're here virtually—safe and healthy, I hope—and look forward to your participation in this session. Next slide, please.

You are in the right room virtually if you're here today to participate in the Data Center Sector Meet-Up. We have a wonderful session prepared today with fantastic speakers that have a variety of data center topics they will talk about.

Before we dive in, there are a few housekeeping items I would like to cover. Next slide.

Please note, today's session will be recorded and archived on the Better Buildings Solution Center. We will follow up via e-mail when today's recording and slides are available. If you experience any audio or visual issues at any time throughout today's session, please send a message in your chat window located at the bottom of your Zoom panel. As the attendee, please ensure that your webcam is turned off. This will help minimize any distractions or draw attention away from the panelists. Next slide.

So, I'll be your Moderator for today's Meet-Up. I'm Rachel Shepherd, I work for the U.S. Department of Energy at the Federal Energy Management Program *[Cross talk]*. It's an office within the Office of Energy Efficiency and Renewable Energy. I lead the Data Center Challenge and Accelerator for Better Buildings. Next slide, please.

We have an action-packed agenda for you today. We are currently in our welcome and introduction section. Next, we'll hear from our experts at the Lawrence Berkeley National Laboratory, who will be giving an overview of the data center sector and energy related barriers and opportunities for different data center types. This is a high level overview that many of you may be familiar with, but others, it may be new to.

Next, we'll hear from our Data Center Challenge and Accelerator partners. They will be giving a brief summary of the efforts that they've been working on the last few years and their experience as a Better Buildings partner.

Next, we'll answer your questions that you all may have. I encourage you to enter your questions into Slido, which we'll talk

about in a moment, throughout the session, and then we can address them at the end. And then lastly, we'll do a brief wrap up. Next slide, please.

So, if you're interested in learning more based upon what you hear today, I welcome you to join the conversation on social media via our Twitter handles and LinkedIn pages. Next slide.

So, we're excited to announce today that we're using an interactive platform called Slido for Q&A and polling. So, please go to www.slido.com using your mobile device, opening a new window in your Internet browser. Today's event code is #bbsummit. Once you enter in this code, please select today's session title in the drop down menu, Data Centers Meet-Up. If you would like to ask the panelists any questions, please submit at any time throughout the presentation. We'll be answering your questions near the end of the session.

I'll give everyone a moment to open up Slido and select the Data Centers Meet-Up session.

Great. Next slide.

So, if you're having any issues, please contact our Technical Support team by using the chat function in Zoom.

So, now, I'm going to briefly introduce our panelists. First, we have many speakers from the Lawrence Berkeley National Laboratory—Dale Sartor, Steve Greenberg, Ian Hoffman, and Hannah Stratton. LBL provides technical expertise to the Better Buildings Data Center Challenge and Accelerator as well as they are a Better Buildings Data Center Accelerator partner themselves.

Next, we'll hear from our partner panelists David Grant with Oak Ridge National Laboratory, Jim Henry with Iron Mountain, and John Sasser with Sabey Data Centers.

Thank you to all our panelists for being with us today and sharing your insights. We really appreciate your partnership.

So, let's kick things off. Next slide, please. So, we're gonna launch a poll in Slido and we're excited to hear from you all. If you haven't already, go to slido.com and enter in code bbsummit and select Data Centers Meet-Up from your drop down menu.

Our first poll is, from a scale of 1 to 5, how familiar are you with data centers—5 being very familiar, 3 being somewhat familiar, and 1 being new to the sector or building type?

We'll take just a minute for you to enter in your response.

And Hannah, if you're able to pull up the results of the poll on the screen for all of us to look at?

Hannah Stratton: I'm seeing them on here, Rachel. So, you guys, can you see the answers of 1 through 5?

Rachel Shepherd: No, we just see the slide right now.

Hannah Stratton: Sorry, one minute. Can you see them now?

Rachel Shepherd: Yeah, that's awesome. Great. So, it looks like we've got a good split. We've got a lot of experts, we've got a lot of people that are somewhat familiar or close to being experts as well as some that are new to the sector. So, this is great. This is a great split of people attending today. So, don't go anywhere with Slido. We're going to do another poll. So, Hannah, if you could go to the next poll.

We've now learned how much you guys are familiar with data centers, and let's see what sector you may come from so that we know, you know, what sectors we're addressing in today's session.

So, the question is, what sector does your organization represent—industrial; commercial; higher education; federal, state, and local government; consultant or engineer; data center provider; or other? And the results are on the screen as well. So, we've got a good amount of federal, state, and local government in our virtual room today, which is awesome, as well as data center providers and industrial consultant engineers. This is great. I'll give another minute just to see if anybody else will enter anything. Alright. Thanks for doing the polls, and let's move on to the next slide.

And Hannah, maybe you're doing the switch, but right now, we're still seeing the results.

Hannah Stratton: Okay. I thought I'd done a new—see, let me… Are you seeing the slides now?

Rachel Shepherd: Yeah. Thanks, Hannah. Alright. So, for those of you who are not familiar with Better Buildings, it's a voluntary partnership between

DoE and an organization to help set and meet goals around energy efficiency, although we have other related efforts such as waste reduction and workforce development, which you may have heard in the open preliminary today. The main goal of Better Buildings is to help improve the lives of the American people by driving leadership and innovation. There's an impressive list of all Better Buildings partners that represents Fortune 100 companies, national labs, top U.S. employees, state and local governments, as well as commercial and manufacturing space. I encourage you to look on our website for the list of these organizations as well as the solutions they've implemented to help meet their goals. Next slide.

So, Data Centers as a part of Better Buildings is split up into two categories. First is the Better Buildings Challenge. These are large organizations that have committed to a portfolio wide goal of at least 20 percent energy infrastructure intensity reduction or POE minus 1 over 10 years. We have nine challenge partners that have committed to reducing 331 megawatts of electric power, and I'm happy to announce that the majority of our partners have met and exceeded those goals as well as committed to additional goals. I'm excited to hear from two of our Challenge partners today, and I want to thank and celebrate all our Challenge partners for their excellent work with DoE, feedback and participation with the Better Buildings Data Center Challenge. Next slide.

Next, let's talk about the 21 Data Center Accelerator partners. This is a short term effort over five years focused on one or more data centers within an organization. The Accelerator goal is a 25 percent energy infrastructure intensity reduction. The Accelerator is now complete, and I'm excited to share with you the results. Before I do, I just want to take a minute and thank all our Accelerator partners for your participation, hard work, and exchange of ideas and best practices that help other partners, help DoE, and really, the data center sector at large. Next slide.

So, I'm really excited to share the results of the Better Buildings Data Center Accelerator. On average, Data Center Accelerator partners have improved their data center infrastructure energy intensity by 36 percent, surpassing the original goal. This has resulted in a $3.9 million annual cost savings amongst all the partners. Again, this is excellent results. Partners have proved successful projects yielding great energy and cost savings. I really look forward to hearing formulary our two Accelerator partners later today and the journey of getting their results. Next slide, please.

As I mentioned, both efforts, the Challenge and Accelerator, are concluding this year. However, there are several ways you can continue to partner with DoE to work on your data center needs. First, you can join a Better Buildings Challenge, dependent on what sector you are in. As I mentioned before, you know, everyone has a data center and it's really cross cutting, and data centers can be addressed both in the private and public sector like the links seen here below with the commercial sector, higher education, and industrial groups.

We'll also be touching on this in a few minutes, the different sectors, giving an overview of them and particular barriers and best practices to address. You can also reach out to FEM, the office I reside in, if you are a federal agency looking for support on energy related issues in your data center. And lastly, you can reach out to Better Buildings whether you're a partner or not if you have any questions through the Better Buildings e-mail address. Next slide, please.

So, now, we're gonna have another poll. So, if you closed down Slido, please open it up again. Our poll is—what type of data center do you work in? And it should be coming up in just a second on Slido. And Hannah, I don't know if you've updated the poll for the new—for poll three?

Hannah Stratton: Yeah, I'm getting it right now. Sorry about that.

Rachel Shepherd: Great. No worries. So, give folks a second to open up again and if you have any questions, please put it in the Q&A section. Alright. So, the question is, what type of data center do you work in—a small data center, enterprise-wide data center, collocation data center, hyperscale, or high performance? And if you don't work in one, you can also share which ones do you work with, if you consult with one, or if you have one.

And we're seeing the polls live right now. It looks like we've got, again, a really good mix between enterprise-wide, collocation, high performance, small data center, as well as hyperscale. I'll give a few more seconds for people to add in. High performance data center sounds to be at the top, which, you're in the right place, because we'll be having a presentation on high performance computing.

Alright, last slide before we dive into the presentation. And I'm gonna give a minute for Hannah, if you wanna switch over to the last poll. We'd like to hear from you of what is your role in a data

center. And it should be coming up in just a moment. So, enter in a word for what is your role in data center, whether that be an energy manager, an IT professional, maybe a sustainability or energy manager. So, if you can take a second to enter in your title or role in a data center and the results will show up in just a moment on the screen.

Hannah Stratton: Are you seeing the results, Rachel?

Rachel Shepherd: Yeah, I am. Thank you. We've got a lot of energy managers, energy engineers, sustainability, also modeling, energy consultant, design engineers—that's great. Also, seeing R&D, which is exciting and fits well with the high results we've got for HPCs. Facility folks, that's great. I'll give another moment or so. I'm hoping to see a few more IT folks out there. If you work in IT, love to hear from you. Awesome. I see some analysts, technology provider—great.

Alright. Hannah, if you're able to switch over to the slides again, and I will give an introduction for our next section.

Alright. So, now, I'm gonna turn it over to two of our data center experts at Lawrence Berkeley National Lab who are going to give an overview of the data center sector by sector type as well as data center type. This information will be published on the Better Buildings website soon, but we're premiering it here for you all to hear first. Again, this is an overview, especially for those who are not familiar with data centers or how data centers fit into your organization.

So, first we'll hear from Hannah. Hannah is a Program Manager at LBL. She supports a number of programs including conducting research and analysis and providing programmatic management and development and support. She has an MBA with a focus on energy from UC Davis and a Bachelor's in Political Science from UC Santa Barbara.

Then we'll hear from Ian Hoffman, who is a Researcher at LBL. His work concerns energy technology development and adoption, energy policy, economics and projections, and science and policy communications. Ian has a Master's degree in Energy and Resources from the University of California at Berkeley.

Hannah, I'll turn it over to you.

Hannah Stratton: Thanks, Rachel, and thanks, everyone, for bearing with me as we manage back and forth between the slides.

My name is Hannah, as Rachel mentioned, and I work with the Center of Expertise, and I'm going to be giving a brief overview about energy efficiency opportunities in data centers, specifically how they relate to the different sectors and also talk about some of the work that we did to sort of assess the barriers, opportunities, and needs across each of these different sectors.

So, data centers, as we all know, support critical operations in a wide range of sectors. They, you know, increasingly are integral to different organizations and really help them carry out their distinct missions. And data centers can represent a significant portion of an organization's overall energy expenditure, and that's why when organizations are looking for ways to save energy and cut costs, they really, you know, deserve a good look. Data centers can be 10 to 50 times more energy intensive than other typical building floor space. And so, you know, for that reason, energy efficiency measures are really poised to deliver substantial energy and monetary savings.

So, the energy efficiency opportunities, challenges, and needs do vary across the different sectors. And I just want you to keep in mind, as I talk about these different sectors, you know, we realize that there is so much diversity within each one of these.

So, we took a look at data centers in the state and local government, federal government, higher education, commercial and industrial sectors, and as part of the Better Buildings toolkit, have developed a couple of resources for each of these.

So, you know, across and within each of these sectors, there's different factors that influence the needs, barriers, and opportunities relative to implementing energy efficiency improvements. So, you know, first, just industry and sector trends—you know, what's going on in that specific sector, and again, there's a lot of different kind of niches within each of these. But just to give an example, you know, in higher education, there is obviously a lot of online learning happening, maybe now more than ever. So, there's just different trends happening that sort of change the game and maybe require more capacity than was previously needed. And then also data center type, of course, affects how somebody might approach energy efficiency in their data centers. Ian's gonna touch on this a bit more after me, but you know, whether you have an HPC data center or a small data center,

you know, it's a big difference. The fundamentals can still be the same, but that's going to be a different approach, most likely.

Also, the organizational structure and dynamic. You know, how diversified are your energy management responsibilities? Does Facilities purchase equipment or does somebody else? And also, what's the relationship like between Facilities and IT? You know, these are just examples of things that may affect a project. Funding availability, of course, whether you're resource constrained or have capital and a C suite that's willing to devote effort and funds to that. And then also, regulatory requirements—federal government agencies, you know, have to comply with the Data Center Optimization Initiative, known as DCOI. So, that will maybe serve as an impetus for making energy efficiency improvements, but also compliance with any regulations that organizations need to comply with, but also help guide what changes or upgrades they choose to make.

And then, of course, you know, the current state of the data center depends on where you're starting from. Are you starting from a legacy data center that was assembled sort of piecemeal, or do you have something that is a bit more advanced? So, the baseline, of course, will influence a project.

So, yeah, just wanted to reiterate that we've developed these sector sheets for each of these that does a bit of a deeper dive to look into what's happening in these different sectors and where we see some of the barriers and also some of the great opportunities for energy efficiency, and we also have pooled some resources specific to each of these sectors. So, as Rachel mentioned, they'll be up on the site soon and we encourage everyone to go and take a look and see what's happening in your sector and also what's happening in others.

So, while the opportunities and barriers and needs do vary between these sectors, there's also just some common themes, specifically when it comes to needs that data center owners and operators have today.

So, first is a heightened demand for capacity. I think, you know, we all intuitively can understand that we've been along a path of digital transformation and that that is still going to be in the future and that we're continuing down that trend. So, this is really demanding a quick ceiling of IT capacity. So, now more than ever, Facilities and IT have to work together to close that gap between demand and capacity.

Next is reducing the management burden. So, a lack of standardization in data centers can result in inefficiencies and a higher management burden for staff. So, as organizations look to expand their capacity, you know, they have to often do that in a strategic way and think about what operational efficiency gains can sort of accompany that expansion to make sure that it's manageable from a staffing and budget perspective. And luckily, energy efficiency opportunities, you know, often have that added benefit of streamlining operations.

Next, risk management and reliability. You know, this is—reliability especially is a constant need. Data centers are mission critical. They play a really important role in organizations. So, you know, reliability is always going to be a need for data centers, and that's always going to be a top of mind concern as people make changes. That's something that nobody is going to want to sacrifice.

And then security—data breaches are costly. Monetarily, they can be costly, and then also just from a reputation standpoint.

And then lastly, touching back on requirements. You know, some data centers will need to comply with certain regulations. So, you know, that can be a need, depending on the sector.

And, you know, as I mentioned before, we realize that these sectors are diverse, they have a lot of—they are quite large umbrellas. They encompass a lot of different organizations that all have very unique experiences with their data centers and energy management specifically in their data centers, and that it really varies quite a bit depending on what the data center type is. So, whether you have a small data center, enterprise, collo, hyperscale, or HPC. So, you know, this is just sort of a mapping of where we see, you know, what kinds of data centers we feel are most common among all of these different sectors. So, again, the experience is going to be vastly different between some of these different organizations. So, you know, the barriers they have, the opportunities they have, all relative to energy efficiency, will be quite different.

And I'm now gonna pass it off to Ian, who's going to dig in a little bit more into all these data center types and talk about the needs, barriers, and opportunities.

Ian Hoffman: Thanks, Hannah. So, I'm not gonna go back over a lot of the material that Hannah just covered. We're very cognizant, though, that there is not one size that fits all on the efficiency front. We see a lot of variability in the opportunities, and the ways in which people can take advantage of those opportunities, timing questions, and a lot of it turns on some of the factors that you see on this slide, you know, how—what level of criticality you have in Operations and how that flows into demands for availability. We talked about, Hannah discussed kind of the differences as you work through the management structure and what the relative roles are for IT versus Facilities versus the folks who are paying the electric bills. Scale obviously is very important, and performance requirements. Next slide.

And so, here's kind of how we see things break down. I think this is a familiar topology, starting with small data centers that, you know, may be tucked into an office somewhere, but historically, they've accounted for a huge share of the server count and for energy consumption nationally. Enterprise centers are close behind in consumption traditionally, and for every organization that has one, their data center is absolutely critical to their operations.

And so, you know, they typically have some high demands for availability. That has energy implications, obviously, and collo facilities, you know, can have thousands of tenants, all with their own IT equipment, their often unique needs for infrastructure. Hyperscale facilities are where we see a lot of the load migrating today—massive energy and water requirements, but generally more efficient than almost anything else in the data center fleets generally. And, you know, we also see them increasingly turning to renewables on site for primary power. Lastly, we have kind of the high performance race cars of the fleet, you know, once the province of academia and government labs such as our own, and now they seem to be ubiquitous in the private sector. Next slide.

And so, just very briefly, I wanna look at the overall energy picture, how it breaks down. This is an analysis by a team here at Berkeley Lab, Arman Shehabi and his colleagues, and their latest estimates and projections can be found in *Nature* just a couple of months ago. But they're showing dramatic shifts in the composition of energy consumption by data center type, and you can see this, right? In the light pink, you can see how large the consumption for small data centers has been, still roughly a third of the total, but shrinking as loads migrate to the cloud. And, correspondingly, you can see how energy use by the cloud and other large tech providers has soared, nearly tripling to the present.

So, let's dive in a little more deeply and, as Hannah indicated, small data centers are everywhere. And, you know, the picture is pretty mixed. This is a pretty pristine depiction. Even in our own building at the laboratory, we've seen some deployments of small data centers that have a lot of very informal infrastructure, we'll say, associated with them. The biggest opportunities, efficiency opportunities we see are migrating those loads to the cloud and consolidating all these scattered racks into larger, more centralized facilities.

In the enterprise space—next slide. Sorry, we just talked about small data centers. Can you bump it one more? Thank you very much.

We see a very high demand for up time, for availability. There remain large opportunities, though, for migration and consolidation, but for the enduring enterprise fleet, we see a lot of savings available and generally low cost improvements in air management, in hot and cold aisle containment, and increasing the inlet temperatures within the recommended ranges in the latest ASHRAE guidelines. Next slide.

The challenges for collos are myriad. You know, the number and diversity of stakeholders can be huge. And, as you'll hear shortly, there are still lots of ways to make efficiency work by setting up some standardized efficient infrastructure for tenants to use and unifying tenants around efficiency as a way to control their costs. Next slide.

As indicated earlier, you know, here at the hyperscale, this is where load is headed, and the sheer scale of these facilities is daunting, but it also presents lots of opportunities, you know, including liquid cooling, high voltage, direct current we see in the future. And, you know, so we see a lot of the larger tech players moving in that direction. Next slide.

And lastly, we come to HPCs. They already have high utilization rates, and there's little opportunity for moving those loads to the cloud or for virtualization, but lately, they've been leading the charge on passive liquid cooling and increasingly active liquid cooling. We see some novel cooling tower designs and there are some opportunities in terms of maximizing free cooling. And with that, I'll hand it back to Rachel.

Rachel Shepherd: Thanks, Ian and Hannah, for that great kinda introduction and overview of some of the opportunities in data centers. And now, I'm really excited to introduce our first partner who's gonna share their experience and success with energy efficiency in their data center.

So, first up is Jim Henry. He is a Compliance Analyst for Iron Mountain Data Centers where he works both information security compliance and energy governance. He is primarily responsible for overall program management and development of the energy management system as well as managing the information security internal audit program of their data center business line. Jim?

Jim Henry: Hey, good afternoon, and thanks for the nice intro. Yeah, so, a lot of folks on this call are energy managers and you're in the industrial scientific side, so you might wonder, you know, why is a risk and governance guy in energy management? Next slide, please.

And we can cut to the chase on how this works inside Iron Mountain Data Centers. So, like Rachel said, I work in Risk Compliance and Governance, and a lot of the story behind Iron Mountain Data Centers' involvement in energy management, it's definitely, it started a couple years ago and it started with Better Buildings. And kind of how we decided that we were going to take some initial steps as we were growing as a company to kind of formalize some of the plans that we had in place. Next slide, please.

So, that said, I mean, at a—just to give you a snapshot of what we look like, we've got roughly 15 data center locations, 1,300 plus collocation customers. We used over 569,000 megawatts in 2019. We have multiple energy efficiency projects across the board. I would say there's a lot more than 15, but 15 that are major. And then we're powered by 100 percent renewable sourced energy. And we've recently—and I think it's coming online pretty soon, here—recently installed the largest data center rooftop solar installation in the data center industry. It's about 7.2 megawatts. Next slide, please.

So, this is kind of how it all starts out. We've got a diverse group of folks at Iron Mountain that work on energy management, so I'm not the only one. I'm more in the governance part of it, right? So, back in 2016, we had three sites—one in Pennsylvania, Kansas City, and one in Northborough, Massachusetts. Those two sites began in the Better Buildings program and set an initial goal of

improve our energy efficiency in general, but ultimately reduce non-IT energy intensity by 25 percent over a 10-year period.

Over the next couple of years, we had some serious growth, but in 2017, based on what we were doing in Better Buildings and realizing the benefit that we saw, not only for ourselves but the industry in making energy efficiency strides, we decided to go for a formal certification. So, you know, that, of course, comes in the form of ISO 50001 and our energy management system certification. 2017 was a busy year for us. We were starting to do some M&A, and that was the year that our entire portfolio was certified. And it was a handful of sites at the time, but what at the time I didn't know was, we had some serious growth coming in front of us. So, in 2018, we acquired a data center company in Denver, Colorado. We had two data centers coming into our portfolio in Singapore and in London, and then also, we acquired IO Data Centers, which was four sites, a couple of which are pretty huge.

So, we scaled from three sites in 2016 up to roughly 10 or 11 in just two years. So, that posed a challenge to us from an energy management strategy standpoint and from a governance standpoint. So, you know, I've been involved for a couple years at that point and from a compliance perspective, which is kinda my bread and butter, I was getting used to working with a lot of different stakeholders, not only from our corporate energy management side, but also facility managers and folks that were actually running the projects and working with them on data acquisition, how we can really amplify what we're doing, get better at the data governance, and get better at improvements.

All that said, we ended up with an ISO 50001 certified system, and we were the first data center company to do that, which was kinda cool. We had, you know, 10 plus data centers in the system, and even now, through a couple more acquisitions, our entire portfolio certified. And that’s a great way that we monitor, measure, and keep that continual improvement story going.

And then, you know, past that, just last year in 2019, we kept that pace going. We were actually able to hit that original goal that we set in 2016 by reducing the non-IT energy intensity in just three years. So, with that said, we set a couple new goals with Rachel and her team this year and got a new site into the scheme. And we're working on bringing all of our sites up to specifications where we can monitor and measure our really granular energy data

points so we can eventually get them into the system into Better Buildings.

So, right now, kind of what we're working on is not only just writing off some of those initial goals that we set and keeping up what we've been doing, but also working in the new goals, kind of how we want to strategize our governance going forward. We launched a new program called Green Power Pass where we're actually able to pass through our renewable power to our collocation customers, which is pretty neat; there's a slide on that at the end. So, next slide.

Alright, so, some of our projects—and I'll speed through these because it's a high level overview of what we have going on. Our Pennsylvania data center is 220 feet underground, and one of the ways that we do energy efficiency down there is actually, believe it or not, through a lake. We have a lake underground in the data center, which is pretty unique. So, it's actually a part of the natural water table in Pennsylvania, and we use it kind of as a natural radiator. We utilize free cooling there in the winter as well, so it makes for a really efficient environment. It's a place where we have a lot of containment, which—if you go to the next slide, please—I think we have some around the containment.

In 2018, 2019, we launched a pretty large containment project. This is just one of the data hauls that we worked in. We basically did some energy efficiency studies on the specific data hauls where we were working. One of those data hauls, we actually ended up just a couple months after the project was complete tuning fan speeds, tuning the BMS and making sure everything was working right, blanking where customers didn't have actual gear resulted in a 10 percent resulted in POE just for that data haul, so it was a really, really big accomplishment for us and kinda set the tone for how we do things in that data center, and it's a little challenging being underground—everything's different, so. Next slide, please.

So, this was just a little bit of the data and kind of what it looked like in the end state. Of course, you've seen one data center, you've probably seen all of them, but for the most part, you know, the containment, in addition to tuning those fan speeds and looking at just that isolated part of the data center, we were able to see and recognize a clear drop in POE for a data center that was pretty heavily loaded down, which certainly helps in collocation, but it was great to just do this and kinda set the tone for what we were doing underground. Next slide, please.

So, another one of our sites that's actually enrolled in the challenge is our Kansas City data center, which is also underground, just not as deep. We've done multiple containment projects and, over the last couple years, we've really pushed down that POE and, you know, thinking about the whole data center, right? So, we're including spaces that are a little bit more empty, a little bit less loaded down. That impacts your POE in a collocation environment. It's not a supercomputing environment, it's not a hyperscale environment.

So, you've got a little bit of a challenge and we're continuing through air management, tuning fans, and just figuring out how to do what we can do in the environments we're in, how to bring the POE down. And as you can see over the last roughly two years, we've brought that down quite a bit in that data center. And again, being underground, there's a couple different challenges in what you can do, so—next slide, please.

So, our Manassas campus is one of the new ones that I've noted and I can probably rap after this and let you guys know that we've set some pretty aggressive goals around the Manassas campus. This is a fairly new data center that's getting loaded down over time, but we really want to realize the importance of tuning our BMS systems, working with the teams that are boots on the ground and really putting, you know, rather than just an energy management system, a governance framework around data reporting, data acquisition, and looking at things with our management teams to make sure that we're doing what we need to do and drive our POE down. Next slide.

So, this is just a couple more photos of the Manassas data center. The left is what it looks like before everyone moves in when, you know, we're kinda just pushing air around and waiting for folks to bring gear in. And the right picture is of one of our cray alleys with all of our brand new gear that we're standing up there. Next slide.

And the last thing I'll just touch on before it kinda wraps to the last slide or two is that we're testing out a lot of new containment methods, you know, things from CPI, Chatsworth, and Schneider Electric. This is the ExoStructure pod that we were testing at a new data center that we just built in Phoenix. So, we're really invested in the system. We're really committed to just driving the POE down and in hyperskill data centers, which is kind of the business we're getting into where large data hauls are just being leased out by an entire company. We're really trying to implement strategies that work as best we can. Next slide.

And lastly, I'll just touch for two more seconds on kind of what we've done with Green Power. I could talk forever about this, but in a nutshell, you know, we've been able to, been fortunate enough to be in an industry where folks really start caring about their impact on the environment and energy use, right? So, it was a really nice goal for us to kind of get our renewables up to 100 percent for the portfolio and to be able to pass that off to our customers.

And we use the ISO 50001 management system as kind of the validation of that data to have a third party come in and say, you know, "Your facility load is this, all of your IT load that's covered by your customers"—reconcile all that with our renewable energy certs and how we source our renewable energy and, of course, pass that on to the corporations and folks that are leasing space in the data center. So, not only are we using our energy efficiently in a responsible way, but we're also trying to pass some of that off to our customers, and that's had a great impact on getting them close to their RE100 commitments and science based targets.

So, we're making as many strides as we can and doing more good and less bad, and hopefully we can keep it up. And DoE was kind of the catalyst for a lot of this back in 2016. And I think that might be the last slide, hopefully. Awesome. Thank you.

Rachel Shepherd: Jim, that was great information. You guys are doing a lot of great work, and I'm excited to introduce John Sasser next, who is the Senior Vice President of Operations for Sabey Data Centers. With over 20 years of management experience, John is responsible for developing the conceptual basis of design and operations for all Sabey Data Centers, managing data center and client relationships, overseeing construction projects, and planning for electrical utility capacity.

John, you're up.

John Sasser: Thanks, Rachel. Next slide. Next slide.

So, just to tell you a little bit about Sabey Data Centers and who we are. So, again, a collocation provider. We're more in the wholesale collocation and power shell area. So, we lease space, power cooling to large customers. So, powered shell for us means customers are operating their own infrastructure and wholesale collocation means we're leasing the power, the cooling, the physical security to some of the larger customers. We have

campuses in Washington State, so both in the Seattle area and then also in Central Washington where there's abundant hydro power—that's our Intergate Columbia and Quincy campuses. We have a campus in Ashburn, Virginia, and we have a mixed use office and data center in lower Manhattan, the 32 story building you see there at the base of the Brooklyn Bridge. Next slide, please.

So, I've been with Sabey for 17 years, and we've been leasing data center space to customers for over 20 years, and efficiency has always been something that's very important to us. The latest Uptime Institute Survey—and this is as of 2019, so it may be a little bit dated, but I don't think it's changed much—is that, according to their survey, the average industry POE was 1.67. At Sabey, our most efficient data center average annual POE is 1.13, and our portfolio weighted average annual is 1.32.

And people have talked about POE and I think a lot of people understand what it is, but for those who might not understand, it's essentially a measure of energy overhead. So, a perfect POE is 1; anything above 1 indicates energy being used by something other than the IT equipment.

So, we've, for really 10 plus years, more like 12 years, had some practices that we've put in place to achieve those sort of efficiency numbers. So, back in 2008, the first data center that we actually designed ourselves as opposed to working with the customer on their design, we required hot aisle containment, and we've required hot aisle containment in all of our new data center designs since then. The airflow management is really important in obtaining very good efficiency numbers. In all of our data centers since 2008, we've put in place some form of economizer. Cooling tends to be the second largest load after the IT in terms of the energy used at a data center. So, it's very important to use at efficiency. Economizer essentially lets you cool the IT equipment without using mechanical cooling. You can compare it where mechanical cooling is running that air conditioner and economizer is similar to opening the window and using a fan.

Speaking of fans, we use variable speed fans at all of our data center, and we control the fan speed on differential pressure. So, what we're trying to do there is, we're trying to match up the air that we're moving with our air handlers to the air that the servers are using. So, with containment, you can do that via differential pressure. So, as the server fans pull more air, the differential pressure set point goes out of whack and the controls act to

increase the fan speed and catch up with that air flow. And it happens very seamlessly if you have good containment.

We build out data centers on slab. So, we have not built a data center with a raised floor since 2008. That was very much an unusual thing back in 2008, but now it's becoming more common, and of course, we use high efficiency UPS. The UPSs about 10 to 15 years ago started becoming much more efficient than the ones before. It wasn't uncommon in 2000 to have 10 percent plus losses on your UPS. Now, it's very common to have 3 percent or less losses on the UPS modules. Next slide, please.

Air flow management, I mentioned that, it's very important. We use hot aisle containment, but it's not just about the containment that you build around the servers, whether that's a chimney cabinet or a pod. We also have to manage the cabinets themselves, and as with a lot of efficiency measures, that involves interaction with the users and, in our case, it's, the customers are actually loading the IT equipment and selecting the IT equipment.

So, typically, these racks that you see in a data center are not fully loaded, and so, you need to have blanking plates between the servers. And very often, the network switch manufacturers are not overly concerned with proper air flow. And so, they'll design equipment that pulls in air from the back and discharges to the front or side to side, that sort of thing, which makes it more challenging to manage your airflow. There are solutions for that, and what we've sought to do is work with our customers to help them implement those solutions. Next slide, please.

I mentioned economizer cooling. We use that in a lot of different areas. Indirect economizer cooling has been very effective for us. In Central Washington, where we have a couple of campuses, we've used indirect evaporator economizer cooling, and that is where we have our most efficient data centers. It essentially has three modes. It has one where it's running dry and you're just rejecting heat through the heat exchanger. Then, as the outside temperature warms up, you start to add water and cool down the temperatures—that works best in dry climates, like we have in Central Washington. And then, in those hottest summer afternoons of the year, we turn on trim DX cooling to get the supplied air temperature that we are seeking. Next slide, please.

So, we've participated in the Better Buildings Challenge for a number of years, and I've found it to be very helpful. A lot of these efficiency concepts, as I mentioned, we've been putting in place for

a long time. But I've had the opportunity to network with some very forward thinking practitioners, many of whom I don't interact with as much in some of the other industry associations. I've had some very interesting tours. NREL near Denver, that particularly stood out. It's a very innovative data center that, again, I had not seen that type before. We were introduced to the Green Lease Leaders program through the Department of Energy and we've participated in that at the Gold level. And then just the various networking and presentations that I've been able to see have been very beneficial. Next slide, please.

So, our future goals—an increased focus on renewable energy. Being in Washington State, we've benefited from the hydroelectricity that's very prevalent in Washington State. As we branch out to other areas of the country where we have a focus on obtaining renewable energy, not just in our other sites, but also as we look at site selection, renewable energy is part of that.

And then the other one that we're looking at is water conservation. Historically, compared to thermoelectrical generation, if you use evaporative cooling at your facility to increase the efficiency, you're coming out ahead overall. So, you're using less water because you're saving electricity. There was a study that Rocky Mountain Institute did on that several years ago. As you work towards more renewable energy, especially solar and hydro, that may no longer be as accurate. So, we are focused on water conservation and the various cooling technologies that are available that don't use water.

So, those are some of our future sustainability efforts and we look forward to continuing on this pathway. And that concludes my presentation. I look forward to questions.

Rachel Shepherd: Yeah, thanks, John. You guys are doing awesome work and we really appreciate the overview and explaining a lot of the successes you've had as well as the goals you have moving forward.

With that, I want to remind you to go to Slido.com, make sure you type in bbsummit and then select Data Center Meet-Up and you can ask questions to the Q&A box, so you can ask any of our panelists, any general questions, we'll take them at the end.

So, while you're doing that, I'll introduce our next speaker, which is David Grant, who is with the Oak Ridge National Laboratory. He graduated from the University of Tennessee in 2003 with a Bachelor's in Mechanical Engineering. Since 2009, he's been

involved in the design, construction, operation of the mechanical systems supporting Oak Ridge's over 80,000 square foot data centers which houses the Summit, the world's fastest high performance computer, among others.

David, I'll turn it over to you.

David Grant: Alright. Thank you for the introduction, and thank you for the opportunity to share a little bit about what we've been doing at the Oak Ridge National Laboratory. Next slide, please.

So, we started this journey back when we were largely a chill water based cooling system supporting our data centers. So, on this slide, you can see the first floor of our computing complex. The data center toward the back was a roughly 18,000 to 20,000 square foot data center that housed a system called Titan, and then above that data center on the second floor was a comparable sized business enterprise data center. And then, in the lower part of the screen, you'll see the new data center, which has another business enterprise data center above it on the second floor. So, before the data center that we'll talk about today was built, we were largely chilled water based with water cooled centrifugal chillers, and we had roughly 8 to 10 megawatts of data center load coming back to that chilled water plant that you can see towards the middle of the screen with the red pumps.

So, back when we first started, we had that setting and we had a design for our 2018 new high performance system, which would be called Summit, which was going to take the place of Titan, which was actually retired in the summer of 2019. So, today, we'll talk about what we gained, a little bit about the journey and the design and what we're looking towards in the future. Next slide, please.

Okay, so, when we first got the design requirements for this new system, we immediately saw the opportunity to have an integrated, economized cooling system. The original OEM for this system was providing the compute racks, which consisted of 18 nodes and a passive water cooled rear door heat exchanger. And we ended up basically building a centralized cooling distribution system that actually served the entire data center. And as you can see, over the past few years, we've had success, Summit has become the leading top 500 system for 2 years now. In the bottom left-hand corner, you can see how the water enters each node. There are two CPUs and then three GPUs that are all water cooled within that node. Next slide, please.

And so, this diagram shows the cooling system and its major components. Where you see the Summit cabinets, that represents the root or heat exchanger and the cold plate cooling that's taking place inside of each of those nodes. And so, this system was designed for a 70 degree Fahrenheit entering water temperature, and each rack needed roughly 18 gallons per minute, according to the design specifications.

So, water actually enters the rear door heat exchanger first and picks up the air side load from each rack and then leaves the rear door heat exchanger and then enters the rack itself into some manifolds that are inside where the water is distributed to each of those nodes. Once the water leaves the rack, the water is sent back to our central energy plant, where it comes through the economizing heat exchangers first, which are connected to cooling towers, and on nice, cool, dry days, we're able to cool 100 percent of the load within the data center with those economizing cooling towers.

We are in Oak Ridge, Tennessee, which is hot and humid during the summer, and so we aren't able to do that year round, so we installed trim heat exchangers which are then connected to our chilled water systems to take the cooling temperature down to that 70 degrees if the cooling towers were not able to do that. Next slide, please.

Let's see. Okay. So, I do have a little bit of animation, there. So, this is—the red line represents our 13.8 kV lines coming in from the utility. The blue line represents just kind of the general overhead cooling, the piping distribution that's serving that data center. Next slide, please.

And this is a system description that shows what the actual cooling system sees. It sees the rear door heat exchangers, and within the over 325 racks that we have inside the data center, there are over 200,000 square feet of heat exchange surface area on those passive rear door heat exchangers. So, there's just a ton of capability there as far as what's presented with the surface area. And then we have the cold plates, CPU cold plates and GPU cold plates. And then the other losses that are inside the data center that the cooling system has to take care of are the electrical transmission losses, the lights, and the return water piping losses. Because our water temperatures were so warm and close to the ambient temperature, we did not insulate that pipe. And then there were some—there is some rack bypass that occurs where hot air escapes without going through the

rear door heat exchangers. And then we have a VRF system which is purely there just for filtering the data center air and then trimming if we needed it. But the VRF system does not handle any of the sensible heat that's dumped to the data center from any of the IT equipment. Next slide, please.

So, it was slab on grade construction, and so everything had to be designed to eliminate any conflicts that we'd had between the mechanical and the electrical and networking, and you can see here, roughly, what we needed up with. Next slide, please.

This was the data center layout, it's roughly 9,400 square feet. The green represent the 256 compute racks. The red are the switch and management racks, and then the orange are the storage support racks. And you can also see the piping distribution. We basically put the racks in a hot aisle/cold aisle configuration, even though with rear doors, you don't typically have hot aisle/cold aisles. We actually call them inlet aisles or outlet aisles, and we basically put all the water connections for two rows down one of the wet aisles. And then the electrical was distributed overhead over the rack, so we avoided any potential for hazards from drips. Next slide, please.

So, the system performance, we started getting really good data as early as March of 2018. And so, up until that point, we had just had this design on paper where we were targeting the POE would be at least a 1.15. And throughout the process of getting the system stood up, we learned early on that we were going to be able to actually to better than the 1.15, which you can see here from the last roughly years' worth of data, this is a yearly POE, so it takes into account the path, the weight of the loads that were on the system for the past 12 months. And you can see a few upticks there in November and January of this past year when we installed a new system on the original cooling system and we're having to cater to some of its needs, but we're coming in at a 1.09 right now for that data center.

So, where our savings really came in is the fact that we're cooling—we're water cooling with 70 degrees and using those cooling towers more than our mechanical chiller plants to cool this load. So, Summit came in, it can peak at over 11 megawatts, the one system, and so it has really taken over, it's the heavyweight of our data center portfolio right now. And so, we've—over the years, we've shifted from that 8 to 10 megawatts of cooling being on the chilled water system to having the 8 to 10 megawatts of cooling on

this new system that has the water side economizer. Next slide, please.

So, these show some additional benefits or improvements that we've made between the summer of 2018 to 2019. So, these are individual pieces of data that are stacked columns. So, the orange represents the load that is on the cooling tower and the blue represents the load that is on the chilled water system. And they're stacked on top of each other to show you total load. And so, you can see between the 2018 and '19, there's less blue in the 2019, and that's for several reasons. We did have a drier summer and you can see that the total load or utilization of the system went up over time, and we also made controls modifications such as resetting the supply temperature up a degree that also enabled more economization than the summer before. Next slide, please.

Rachel Shepherd: Hey, David, you've got another about minute or two, just to let you know.

David Grant: Okay. Alright. So, here, you can see the biggest savings here going from the chilled water to the cooling towers and the kilowatt per ton, so this is the kilowatts of electricity used by the facility in our centralized plants. And you can see the difference between the total BTUs that we handled with two systems between the two years. Next slide, please.

These were additional things that we did within the data center to further promote savings, and the chart can actually be used by anyone. It just directly shows you the cost and facility electrical cost per year per kilowatt of IT power based on what POE your facility has. Next slide, please.

So, throughout the Accelerator, we gained a lot of knowledge through the networking and the multiple meetings that we had. We focused in on the metering methodology and POE, because our portfolio based POE really became irrelevant after Summit come in because of the weight it had on the POE with looking at it from a portfolio perspective. So, we're going to start doing POE at the data center level. So, instead of one, we'll have four, and that will help us target future improvements. Next slide, please.

So, moving forward, our next system that will be stood up in 2021 or 2022, we're actually eliminating the chiller connection. It's systems name will be Frontier, and it'll be even more efficient than Summit. Next slide, please.

And then for rack densities greater than 10 kW, we're leveraging some of the infrastructure that we're putting in for Frontier to help cool some of the higher density racks that we're seeing in our business enterprise and scientific cluster groups, and this is the general schematic that we're doing there and we're calling this a trim CDU idea, which is a lot like the cooling system that Summit uses, except it pushes the cooling distribution unit out to the data center so that we can surgically provide those cooler temperatures where they are needed. Next slide, please. And that's all I have. Thank you.

Rachel Shepherd: Thanks, David. I appreciate you guys are, you're doing a great job, and if you want to learn more, please reach out to David because they're doing excellent work at Oak Ridge, and so—yeah, thanks for sharing that.

So, lastly, we'll hear from Steve Greenberg from Lawrence Berkeley National Laboratory. He's a Senior Energy Management Engineer. He has researched and applied energy efficient building and industrial systems for a variety of clients for over 3 continents over the past 27 years. Steve holds a Bachelor's in Mechanical Engineering and a Master's in Energy Resources, both from the University of California at Berkeley and as a Registered Mechanical Engineer in California.

Steve?

Steve Greenberg: Thanks, Rachel. So, you've heard about the big guys and big computers, and I'm gonna tell you about the little engine that could. This is a case study of one of our data centers. This is our enterprise data center at the Lawrence Berkeley National Laboratory. Very briefly, I'm gonna tell you about, you know, the old days and an evolution toward the current state and lessons that we learned along the way. Next slide, please.

Okay, so, this data center, in more or less its current form, was started in the 1990s. It had been a data center before that, but it was completely rebuilt to house the supercomputer that we inherited from Livermore. Then that, it outgrew that facility and moved to Oakland in the 2000s. The data center was repurposed for scientific computing and in-house business computing. In the 2010s, its focus has been on high performance computing, owned by various research groups with ever higher compute power densities. The cooling scheme was CRACs, water cooled computer room air conditioners, ejecting to a cooling tower, and even though those CRACs had ample capacity for the load, there was poor air

management and there were hot spots—witness the fans on the left. When you see operating fans in a data center, you know there's an air management problem. They also had the floor grills there that were excessively open, causing—solving the problem in that area and creating problems elsewhere. And the POE was over 1.5, so there's obvious room for improvement on various fronts. Next slide, please.

Alright, so, we worked with the data center folks over there to improve the air management in that facility and got the cooling under control. There was a report on that, and one of the things I want to point out is, this—I call this data center the case study king, because we've done many studies of various types in the data center. And so, others talked about how FEMP and Better Buildings has helped them achieve savings, and that is certainly true here. But the reverse is true, also—there have been a number of FEMP and other reports done based on studies that were performed at this data center and I commend you to those.

Anyway, so, we moved on from the sort of classic CRAC cooling to passive rear doors, both with closed loop cooling water just to the cooling tower with no refrigeration. I know some used a chilled water booster, and they didn't remove 100 percent of the heat, so the CRACs took care of the rest. Then we also used passive rear doors directly with chilled water, and those can provide net cooling because the chilled water is cold enough. We also did some other liquid cooling tests over the years. Next slide, please.

Okay, so, given the constraints of space, power availability, and plant availability, a real value engineering exercise happened. Now, most of you who are familiar with value engineering know that it's a euphemism for cost cutting blood bath. But in this case, it's a real value engineering effort to figure out how to best use the space, power, and cooling available and I think we're on a really good track there.

So, one of them was moving, really, temperature sensitive items which are not the actual computers to other spaces with tighter temperature control and then operate it not as an A3 area, but an A2 area, that's a misprint. But that allows you to go up to 95 degrees inlet temperature to the IT equipment, passive rear doors in some cases, but also active rear doors that use lower power fans to make better use of the water temperatures that are available. Higher delta Ts on the cooling, direct to chip cooling, and the CRACs, all but one of the CRACs are gonna be removed. We're almost there. I think there's two still in there. And we're trying to

max out at 1.4 megawatts and a POE decreasing from 1.43, which was the Better Buildings baseline, to 1.37, which was the final year, ultimately to 1.1. And that's a 14 percent reduction and a 77 percent reduction, respectively. And there are other strategies that have been implemented as part of this including an innovative electrical distribution system. Next slide, please.

Alright, so, what did we figure out? Liquid cooling—you know, we've been doing it for more than 10 years. It's effective and reliable. Rear doors are a good bridge technology from air to warm liquid cooling more directly to the chip. Distribution of heat within passive rear doors—if you have super high density servers, they don't equal out well with the lesser ones. Infosys learned that issue. Control valves and flow balancing, there are pros and cons to those. You can do better optimization, but there's a lot more capital cost and maintenance cost to those. Active rear doors, because they add some cooling energy that's not IT energy, but they unload the IT fan, so it makes the POE worse, but the energy savings, there's still net energy savings. And to keep track of all this, many, many meters are needed, and there's just a few of them, right there.

I think that's it for my talk.

Rachel Shepherd: Awesome. Thanks, Steve. Appreciate you sharing that. You guys are doing great work at LBL on your data centers.

So, now, this is time for Q&A. We have a few minutes for Q&A before we open it up. Can I ask the panelists to please turn on your video and your sound and we can address some questions? And as we're talking, you can enter in questions on Slido.com. There's an option for Q&A as well as for the poll section as well.

So, the first question was for Dale, who walked away from his seat. *[Laughter]* So, I'm gonna ask the panelists. So, there was a question about how does the market see the trend towards—oh, there's Dale—how does the market see the trend towards edge with respect to growth due to the recent pandemic? So, Dale, I was hoping that you could address that question and then if the panelists want to kind of talk more broadly about impacts to the panelists based on their businesses as it relates to data centers. Dale, do you want to kick it off?

Dale Sartor: Sure. Well, I'm sure that others will have a comment on the edge. The edge is sorta like what sustainability was when that word started being used. I mean, everybody has a different definition of

what the edge is. You know, one could just say that all the little tiny data centers that we're trying to get rid of are edge data centers.

But there's a vision that the edge is gonna lead to improvements both from an IT and from an energy standpoint. And, you know, I'm hopeful along those lines. We're seeing a growing demand for edge computing where there needs to be quite a bit of power much closer to the customer, so there's a lot of pre-processing that goes on. And then, you know, a lot of the storage and deeper processing would occur at our central data center.

So—and the reliability needs for the edge might be enhanced and yet they're gonna be oftentimes unmanned. So, sort of failsafe systems and systems that use passive, say, for example methods of control—the simpler the systems, the more reliable they are. So, there's gonna be a lot of interesting opportunities, I think, with edge computing and edge technology.

Rachel Shepherd: Awesome. Thanks, Dale. Any of the other panelists wanna talk about just broader impacts with the pandemic? You can virtually raise your hand, like, physically give a gesture if you want to comment on that, or we can move on to the next question. Okay, *[Cross talk]*?

Jim Henry: I'll raise the hand quickly, because I think that, just like Dale was saying, edge is kind of a buzzword. And, you know, when I'm sitting in my seat in Risk and Compliance, a lot of folks are thinking about how they want to be closer to their gear, but of course, that's not always the best for DR, depending on what you're doing in that gear, whether it's storage, whether it's processing or what have you.

I'd say the one thing that's combating edge right now—and maybe John…in collocation, a lot of folks will say that maybe something that combats edge a little bit is having a good remote hands program where, even if the folks who might need to work on their gear aren't near it, we can have our own folks do certain things for them.

So, I think edge is still relevant, but as far as—at least from my perspective, it's a balancing act.

John Sasser: Yeah. Yeah, we talked about server huggers and, really, it's edge versus core computing. It should be a function of the latency requirements and potentially the bandwidth requirements of a

given application. So, like you and like Dale, I've seen a lot of people with a lot of different opinions on edge compute and what that looks like. And we've seen some of that in our data centers because we do have data centers that are close to population centers. And so, some of those applications make sense for our data centers.

We tend to be more core compute so, you know, like the Central Washington data centers I mentioned where we have a lot of it, that's very much a remote data center where the emphasis is on getting the best TCO for the compute. And so, a lot of compute continues to not require that, not have that sort of latency sensitivity, and so most likely, there will be a mix of core and edge, and that will continue to evolve somewhat as the applications change.

Rachel Shepherd: Thanks, guys. Let's go on to the next question and Jim, I'll go back to you. How do you collaborate—I think you touched on this a little bit, but how do you collaborate with your customers to improve their efficiency?

Jim Henry: Yeah, so, that's tough in our industry in collocation. I'm sure between everyone from a collo, you always go back to a story of a customer that maybe didn't really care about their efficiency, right, they just wanted their gear to work and be on all the time and be secure. So, it's always a struggle, but what we've gotten a lot better at over the last couple years is starting from the beginning.

So, we've had a number of acquisitions, too, so this is even tougher. For Iron Mountain, since 2016, if we've—you know, some of the businesses we've acquired, there's been long-standing contracts, long-standing relationships with folks that maybe it's a little bit harder to foster a relationship of efficiency rather than just always being on.

So, what we've really gotten better at lately with is—and we're still not where we wanna be—is starting from the beginning and saying that, given your load and given your configuration, maybe we can do some hot/cold aisle containment. What's best for you? Do we need custom ducting within your racks? Because, you know, maybe you're running really old gear that's still blowing side to side which, believe it or not, some of the customers are. Which is kinda crazy, you'd think, it's 2020, but we've done custom ductwork, we've done lots of work with the customers. We've 3D printed blanking panels that, you know, for specialized deployments.

So, it really starts at the beginning but, for existing customers, it's more about working with them and letting them realize the benefits of air management and efficiency, whether it's because of risk management and gear getting worn out due to the high temperatures and saying that this plays a part in availability or ultimately just reducing the POE because that contributes to a better build, right?

So, it starts at the beginning, but we're getting better at fostering the relationships into some of the customers that we've acquired.

Rachel Shepherd: Awesome. Thank you. Steve, this next question is for you—have you seen any negative effects on technology for adopting wider inlet temperature standards?

Steve Greenberg: No, not really. The thing is that, you know, it's important to understand that the ASHRAE recommended and allowable guidelines, and if you abide by them, the equipment is perfectly happy.

Rachel Shepherd: Awesome. And this is actually a related question for David as well. David, what are your humidity ranges allowed in your data center and how are they controlled?

David Grant: Right. So, for our newer spaces, we are following the ASHRAE recommended guidelines and so, basically, we've, in our new data center, we control our dew point, we go from 20 to 60 digitals Fahrenheit for the control range. And on the low end, we use ultrasonic humidifiers, and on the upper end, we've found that it's actually controlled—the dew point on the upper end is controlled more by the pressurization air coming into the data center. But we use either the VRF system or CRAC units connected to our chilled water system to control the upper end.

Rachel Shepherd: Awesome. Thanks, David. So, we've only got time for one more question. So, the last question is for John. How are you able to get customers willing to allow 1.13 POE? Were there any compromises related to service levels, UPS, free cooling?

John Sasser: Only in agreeing to use hot aisle containment. So, there's no compromises related to our service level agreements. We follow the ASHRAE recommended ranges. Our customers don't usually let us go into the allowable ranges on temperature. So, we follow the recommended range, you know, standard power reliability. It's

mainly working with the customers on installing blanking panels and that sort of thing.

Since our contracts start out that way, and Jim had an excellent point about trying to—it's easier if you start out on the same page, and our contracts and our _____ made it clear to our customers that we use hot aisle containment, that's what it's about. So, the customers actually benefit. We pass through electricity costs and a lower POE means that they have a lower electricity bill, so our customers are usually very happy about that.

Rachel Shepherd: Right, right. Thanks, John, and thanks to our panelists for answering those questions. You'll have another opportunity to send in any questions that we have through our contact information, which we'll share in a moment.

So, before you leave us today, I'd like to provide you with some actual next steps. I encourage you to go to the Better Buildings Solution Center, which has over 2,800 solutions that will help you find proven and cost effective energy and water efficiency solutions. If you go to the next slide, please.

So, we'd also like to invite you to attend our Better Buildings Summer Webinar Series starting in July. Partners will discuss some of the more pressing topics you're facing and share best practices and innovative new ways to approach sustainability and energy performance. I'd like to point out that on July 28th, the Data Center team which you've heard from today will be presenting on a webinar on "Everyone Has a Data Center: How to Be an Energy Champion for Yours." To register, go to the Better Buildings Solution Center and click on the 2019-2020 webinar series. Next slide.

So, unfortunately, we don't have any time today to do our last poll, so if we go to the next slide, we encourage you to let us know through our contact information any key takeaways or questions or thoughts that you have. With that, I'd like to thank our panelists for taking the time today to talk with us. I'd like to thank you all for taking the time to listen and participate in this session, and if you have any questions or comments, again, please reach out to us via e-mail. You can reach out to me or any of the specific panelists if you have any questions. You can also go to the Better Buildings Solution Center and there's a general e-mail there that you can submit questions as well.

I hope you have a wonderful day and we will see you virtually in one of our other sessions occurring this week. Thank you.

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