Rois Langner: Hello, and welcome to our biannual Better Buildings Alliance Plug and Process Load Technical Team call. This is Rois Langner, and for those of you who don't know me, I am the Technical Team lead for the Better Buildings Alliance Plug and Process Load Team. I am an architectural engineer and a building scientist, in the Commercial Buildings Research Group here at the National Renewable Energy Laboratory, which is located in Golden, Colorado.

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For those of you who are new to this call, this is our Better Buildings call that is focused on solutions to understand and control the energy consumption of all plug-in equipment and miscellaneous electric loads in a building. And those equipment and loads are basically everything that is not related to heating, cooling, ventilation, water heating, or any other major building function. It's everything else that consumes energy in a building, and it's a lot of little things that can add up to a lot.

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As we can see in this slide, which is data from our EIA Annual Energy Outlook 2015, plug loads typically consume over 30 percent of whole building energy use. And this percentage is expected to grow over the next 15 years, due to the fact that other building systems such as lighting, HVAC, and building envelope are becoming more and more efficient, and we're seeing a lot more plug-in equipment becoming available on our market. So, the right side of this graph shows the commercial sector values for 2016, in the third column, and then projections for 2030. So it's expected to grow to about 43 percent of the whole building energy consumption. On the left side of this chart, we see the residential distribution here, where plug loads and miscellaneous electric loads consume roughly 30 percent now, and are expected to grow to 34 percent.

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So, this is significant, and the good news is that, when we introduce plug load controls, we typically see up to 30 percent – and I've actually seen some savings up to 40 percent – for individual pieces of plug-in equipment. And this often translates to about seven to ten percent energy savings for the entire building. So, plug loads are significant and should not be overlooked, and, in fact, they're more and more on the radar of facility managers, these days, efficiency programs, utilities in particular, et cetera. So, it's become a very hot topic, and kind of a next frontier of building loads that we need to better understand and learn how to control.

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So, for today's call, I will start with a few updates from the Better Buildings Alliance Plug Load Team, then we'll go on to our technical presentations, leaving some room at the end for open discussion, Q&A, and any additional partner updates, if anybody has them. So, for this call, everyone will be muted, but please type in questions into the question box on the "go to webinar" control panel, when they arise. And we'll keep track of those and respond to them either at the end of the presentations or as we move forward. We're also going to send these slides out after the call – it will probably take us a week to post them to the Better Buildings Solution Center, but once we do that, we will send a link to all the participants and people who registered for this call, afterwards.

So, our technical presentations, today, will be given by Michael Klopfer and Joy Pixley, from CalPlug. And "CalPlug" is short for the California Plug Load Research Center, which is part of the University of California Irvine's Institute for Telecommunications and Information Technology, which is also known as Calit2. CalPlug is conducting a bunch of research in the plug load space, and a lot of it is funded by the California Energy Commission, and we're very excited to have Michael and Joy on this call, so that we can learn more about their work.

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So, starting with some tech team updates, here, I'd like to introduce Dr. Kim Trenbath. Kim is an industrial engineer in the Commercial Buildings Research Group at NREL. She has been working closely with me to help lead the Better Buildings Alliance Plug Load Team, and will be NREL's main point of contact while I'm on maternity leave, starting here in May. Kim's project at NREL includes this work through the Better Buildings Alliance automated fault detection and diagnostics and zero-energy K-12 schools. Prior to these projects, she was the group's business manager, and previously worked as an analyst in global power strategic sourcing risk management and wind energy business development. Her prior research involved in-cabin air quality science understanding and break-in training. So, I'm very happy to have Kim joining this team, and you guys will all be in very good hands while I am on leave.

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Additionally, I'd like to point out that we've had continued support from Marta Schantz and Sormeh Konjkav, from Waypoint Energy. They have been a tremendous asset to the plug load team, for many years now. I know many of you have worked directly with them, and will continue to do so as the plug load team moves forward. So, between the four of us, that's the leadership for the plug load team here.

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So, some team updates, here. I wanted to go through webinars and conferences, a past webinar that we recently gave, a month ago, February 8, 2018, GSA Proving Ground did a webinar on advanced power strips for plug load controls, which I was a guest speaker on. You can download this webinar; the link's provided there. Or if you google the GPG out brief webinars, you'll see a link to the recording and slides for that webinar.

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There are a couple conferences I wanted to point out. This year, our annual Better Buildings Summit will be held with the Department of Energy's Energy Exchange, which is typically focused on federal facility energy management. The joining of these two conferences will provide greater access to technical discussions and trainings, while also providing great panel sessions, keynote speakers, and of course networking opportunities. So, save the date: the summit will be held August 21st to August 23rd, in Cleveland, Ohio, and we hope you all can join us out there. It's a great conference to attend.

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Additionally, the plug load team will be represented at ACEEE's summer study, which is going to be held August 12th through 17th, in Pacific Grove, California. We are pleased to announce that we had two abstracts accepted around plug loads; one will be for a paper under Panel's 12 Smart Buildings Smart Grid and the Internet of Things. And this paper is focused on how to navigate communication protocols and cybersecurity implications of wireless meter and control technologies for plug loads. I will be the lead author on that one, and working closely with my colleague, Dane Christensen, here over at NREL, who is on our residential group. The second abstract is for a poster display presentation, and this is really focused on how do we use metered plug load data to sense occupancy and implement controls.

And this work will be based off of a project that NREL is conducting through the Wells Fargo Innovation Incubator program, with a smart outlet company called Ibis Networks. We're basically using their smart outlets to meter plug loads in an office space, and understand usage patterns of those plug loads, so that we can determine occupancy, and ultimately recommend control schedules for individual pieces of equipment. So, that study will have preliminary results by the time of the ACEEE summer study, and we're excited to present those during the poster display presentations there. So, hope you guys can join that conference, as well.

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And before we launch into our technical presentations, one more update. This year, the plug load team is focused on a landscaping study, to figure out how to better integrate plug load controls into building automation system and energy management information system platforms. So, basically, this is a literature review to understand the status of the market and where the Department of Energy can really support integrating these controls into BAS and EMIS platforms. And our literature review will focus on, of course, connected devices, wireless meter controls for plug loads, what the dataflows are for the information to get to the BAS and EMIS platforms, how we can integrate plug loads into other building systems, et cetera. We'll look at communication protocols, interoperability with other systems, cybersecurity issues, et cetera.

So, we're excited to embark on that project, and we will be addressing initial findings of this, at the upcoming Department of Energy's building technologies office peer review, which will be in D.C., in the beginning of May, as well.

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So those are the updates from the tech team, and I wanna introduce our speakers, one more time. Again, our speakers are from CalPlug, which is short for the California Plug Load Research Center, which is part of the University of California Irvine's Institute for Telecommunications and Information Technology, that's also called Calit2. And Calit2 is a two-campus multidisciplinary research institute; it's one of four UC Gray Davis

Institutes for Science and Innovation. And Calit2 leverages academic expertise with industry experience, to conduct cutting-edge research in diverse fields. Their goal is to develop innovative information, technology-based products and services to benefit society and ignite economic development in the region and state. Calit2, at UC Irvine, hosts several centers, including CalPlug.

CalPlug was established to improve energy efficiency in the use and design of applications and consumer electronic devices. They focus on energy efficiency solutions, efficiency evaluations of consumer electronics, standards development, education and public outreach, and user behavior studies. CalPlug addresses challenges in plug load efficiency, for both residential and commercial buildings, by collaborating closely with utilities, manufacturers, advocacy groups, research institutions, and energy policymakers. The campus of UC Irvine has asserted a firm commitment to energy efficiency and natural resource protection, as well.

So, Michael Klopfer, the technical director at CalPlug, has a doctorate in biomedical engineering from UC Irvine. And prior to joining CalPlug two years ago, Michael consisted for system design in a number of fields including consumer electronic development, Internet of Things solution development, and medical device design and development. And Joy Pixley has a doctorate in sociology from Cornell, and has worked in the field of survey and experimental research methods, for over 20 years. She is a project manager for social sciences at CalPlug, focusing on user behavior and energy efficiency.

So, with that, let's go to the next slide.

And, Michael, I'll hand it over to you.

Michael Klopfer: Rois, thank you so much for the great introduction. We're very excited to be talking with very *[audio cuts out]* likeminded individuals on a topic that we hold so dear to ourselves. You covered many of the main bases about what we do and what our focus is in the organization, but I'd like to go into a little bit more detail about what our mission is, what we're directed to. And then, lead off onto a particular project that Joy has been working on, which had some fantastic results that we'd like to present towards the end of this disucssiion.

Please advance? Go ahead and click a couple times, just so they all come up – perfect.

As Rois mentioned, we're a multidisciplinary center that's based at UCI, and we have focused on a number of points of commercial and residential miscellaneous loads, and subgroup of plug loads. From this, we have multifaceted considerations that we're looking at, and what this means is, to deal with a number of these problems, they have to be addressed between multiple groups and at multiple levels. This includes the technology level, the policy level, the user interface level, and market and adoption. So, all these pieces have to come together, all these moving pieces have to be aligned to move practical solutions forward, and this is what we do on our side. We host workshops on a variety of plug load topics. Last year, we hosted a European conference on domestic lighting and appliances, called EDOL, and in this, we are hoping to foster connection between international work on this. And even though this is a European conference, there was representation from other locations outside of the United States.

At the same time, we also host workshops on special topics and our own topics that we put together, and bring in individuals from these different groups here, from manufacturers, consumers, retailers, and utilities, to talk about particular topics, and draw out some specific technical and market aspects of this, to go into deep-dive, deep discussion on. In addition, we work with utilities, to develop programs and investigate products and solutions. We've done a number of projects on tier-two advanced power strips, on both residential and commercial side, to understand how these devices can be used to save energy. This is one direction, but we've done a number of other ones that we mention later. We've also worked with manufactures on voluntary agreements, and also with policymakers, to put together new codes and standards.

In addition to this, we work on a number of inhouse events, energy savings control systems, and we do demonstrations of these systems, in addition to looking at what manufacturers have produced, and validating the operation of these from a third-party. As another part of our work, we also focus on education. So, in addition to coming up with solutions, we work with trying to educate the community at large, and also, individuals within the university, on specific energy-saving topics.

Please advance? Go ahead and advance to the – thank you so much.

So, to get into a little bit more about the education side, we have educational workshops that we host here for K-12 students. One particular activity that I'd like to share is our 1-Kilowatt Hour

Challenge, where students will play games that involve using energy that relates to specific household tasks. And from this, they understand what energy is used for these tasks, and accordingly, they offset their own energy with mechanical power. This is a way to show that a kilowatt hour saved is better than a kilowatt hour generated. So, going in and inspiring the next generation is one of the focuses that we have. In addition to this, we work with two dozen undergraduate and graduate students, hand-in-hand, in our collaborative work. So they work with us on the policy side, they work with us on the technical design side, and the goal here is to develop the next generation of clean tech leaders, who can work between technology and policy, in an interdisciplinary fashion.

Please go ahead and advance? Perfect.

So, the major issue with plug loads, as was previously addressed, is that the problem is a non-static problem. So, once you've modeled what's there, the problem is always changing, you have changing devices. For example, on the residential side, you'll have more personal and more distributed devices. This also carries over to commercial; there, you have a little bit more control as far as what's going in the build, but there's many points of integration that need to be built out that can be built out, and there's a lot of opportunity there. In addition, we have changing configurations for these setups. There's a number of opportunities and challenges on the commercial side, as far as building integration and controls, and then, the Internet of Things as far as how this relates to control is another part that we look at. For example, a number of smart bulb solutions, that claim to be producing net savings in many configurations, will actually not save anything; they'll actually use more energy, just because of the sleep state and how the management is working.

So, considering how this fits together in policy – for example, Title 24 has an exception – this is California Title 24 – a building code as an exception for controlled devices. So, figuring how these fit into larger elements is one of the things that we look at.

Go ahead and advance?

So, addressing a couple of these specific cases. The first is integrated and adaptive controls – how can this be drawn out and improved? And extending from this, user interfaces is another concern, and this is gonna be something that Joy is gonna focus on in her discussion. Also, population demographic shifts are a consideration – on the residential side, medical devices in the home is a consideration. But on the commercial side, there's a number of distributed clinics that are out there, and how to integrate energy controls into the healthcare field is still an area that's being explored. Also, decarbonization and electrification – what California is working on, right now, we're trying to remove natural gas resources from new builds, and transfer this over to electrical sourced energy; has a number of issues associated with how energy is sourced, whether it's a distributed load that's coming in. And accordingly, how the demand is set around the loads.

And how plug loads fit in this is something that we're currently investigating. Additionally, on top of that, the transportation side, in California, we have a governor-mandated target of five million electric vehicles on the road by 2030. And how this fits together, and how demand can be managed with charging, either as a resource to provide sloshing of power back onto the grid when needed, or charging at points where power is in excess, is something to consider. And how tying this together with plug loads is a direction that can be explored in the future. With all this being said, I'd like to go ahead and shift over to a specific topic that we've spent the last two years researching. This is related to the controls on computers for energy management, which is something that has been looked at on our side, and Joy has gone into a deep-dive on this, and I'd like to turn this over to her to discuss this in a lot more detail.

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Joy Pixley: Hi. Great. So, Mike gave a really good overview of what we do here at CalPlug, and now I'm gonna dive in and talk more nitty-gritty on one particular project. Now, we've been working on the issue of computers more broadly, and power management, for about five years, now. What we're working on right now is actually the third project we've done so far, so I wanna give you a little background on the first two projects, first.

The first project was a survey of over 2,000 people, where we asked them all about their home desktops, their office desktops, and their laptops. And one of the many things we asked them was whether or not their computers went to sleep. And the vast majority of them said, "Yes, my computer goes to sleep." We were a little bit less for office desktops – we had more people who were confused by that. But we thought that those initial results were very positive. Then we did the second study *[laughs]*, and then we got less positive. In the second study, we actually went and monitored a subsample of just over 100 of those office desktops, and the results for those desktops are what you see here. So the first line is what did these particular people report about their computer sleep settings, and we see that 78 percent of them said that their sleep settings were enabled. But when we looked at it, only 20 percent of them actually had their sleep settings enabled, so that's obviously a problem.

Can you click, please, click to the next one? There we go.

So, this identifies three different groups of people. On the one hand, we have the 20 percent of people who said that their sleep settings were enabled and they were, so we don't have to worry about them; everything's fine with them. We have the 13 percent of people who now that their sleep settings are disabled, and presumably want them to be, and we're gonna put them off for a different project. It's that middle two-thirds that we wanna deal with now, and these are people who either think that their sleep settings are enabled or aren't sure, but they're not. So those are the low-hanging fruit – we hope *[laughs]* – that we want to find a solution for. And the solution that we were proposing was to design and test the new user interface, the new software app, to get people to access sleep settings in a slightly different way, and to give them feedback that was going to encourage them to use these power management options that are already available.

So there's no really serious technological change that has to happen; we just wanna change the behavior so that what's there is actually being used efficiently. This is publicly funded by the California Energy Commission, through the EPIC program, and we take that very seriously.

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So, the name of the project and the name of the app itself is the Power Management User Interface, or PMUI, which is very awkward, so we just call it Pumi. And the first phase, there, is – it's a terrible brand, but we're not into branding; we're into science, *[laughs]* so. So, the first stage is to design the interface, and we wanted to build on the huge amount of research that's already out there on psychology, and behavior change, and human-computer interaction. And particularly on the kinds of intervention programs that have already been done in residential areas and residential applications, where you give them feedback on their household energy use, and see what makes the difference for actually reducing their energy use at home. And so, what worked best for that, how can we utilize that? And the first step for that is to keep it simple.

We're only managing computer sleep and display sleep; we're not messing with things like hybrid sleep or hibernation, or anything complicated like that. The whole idea is that it should be very easy to access, easy to use, easy to understand, and very motivating. So we found, for instance, that people were pretty confused by some of the aspects of the standard, say, Windows or Mac settings. That they would look at their settings and say that it said that it was balanced, but then you look at the next page, and even though it's balanced, somebody has actually set the settings to "never." So, that seemed to confuse people a lot. So in general, what we're trying to do, here, is providing people with actionable information: what is the problem, and what can you do about it.

So I wanna be clear, here, about what our focus is: we are not trying to develop some products that we're gonna sell and make a profit on; nobody is gonna buy this. This is a scientific inquiry into whether we can actually change people's behavior enough to make a serious dent in the energy waste. How well does this kind of feedback work for computers, where we, again, already have this sleep setting available. And maybe, in the future, how can we be able to apply that to other sorts of devices that you have in the home, that, again, have these kinds of sleep settings and the user behavior is important. So, basically, we're in this for the energy savings; we wanna save as much energy as possible. And so, to facilitate that, we made two choices: one of them is that we built the entire thing using only free software and open source software.

That will enable us to have a much freer distribution, much more opportunities to be able to develop this in different contexts and get it out to more people. And we also designed it to be a standalone program. So, a lot of these other feedback programs require that the user be part of some sort of organization where you're gonna compare their usage to their neighbors, or to their coworkers, or something like that, or they have to be hooked up to, say, your utility bill. So, you're comparing your use to how much energy or how much money you are saving compared to last month. And these are great, don't get me wrong, but being able to use these comparisons does limit how you can distribute it.

So we designed this as a standalone, where you can just download it straight from the Internet, and use it on your own computer, for your own use, to save energy. And so, the overall idea is that this will enable us to use this in a much wider range of contexts, from low-income households to small business to large businesses, anybody who wants to use it will be able to save energy.

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So, _____ _____ explain, I'm gonna show you a little bit about the interface itself, and then I'll talk about the study that we're doing where we're testing it. So this is the sleep settings page, and I wanna point out a couple things about it. First _____, like I said, it only has computer sleep and display sleep, and it has a slider for both of those that you'll notice we're using a little bit psychology here, because the middle of the slider bar is 30 minutes for computer and 10 minutes for display. And that's our target level, really; we'd like it to be better, but that's our target. And we're using psychology because we know, from past research, that people don't like to be worse than average. So if we sort of communicate to them that that's the average, they're more likely to be at that point or lower.

The second thing I wanna point out is, look at that little bottom box, to temporarily disable. We were wondering if maybe some of the reasons why people's computers were disabled, the sleep settings were disabled, is because they turned them off for one particular event – maybe they wanted to download something, or for some reason they wanted to make sure that their computer didn't go to sleep – and then there's nothing that ever reminds them to turn it back on again. So, with this, you can temporarily disable it – you click the little box, you can say for one hour or eight hours or three days or whatever you want, and it'll show a sign that says it will come back on at a certain time. Also, then, if you look up _____ "How can I reduce my computer idle time?" throughout the program, we're trying to stay very much on message, that idle time is the bad thing. Idle time is what you are trying to reduce.

So there's a whole of popup buttons and things, that you won't be able to see on this slide, that keep reinforcing that message and bringing you back to this page, and suggesting that you enable your sleep settings and turn them down. If you look at the menu bar on the left side, you'll see that, in addition to the sleep settings page, there are three different reports. So the idea there, again we know from past research that different people respond to different kinds of reports, different kinds of graphic interfaces. And so, we wanted to do a number of different ways of presenting this data, of giving them feedback, to have a higher chance that any one person is gonna be engaged by one of them.

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So this is the main page, this is the usage report page. And if you look at the pie chart on the left, this is your computer state. We've simplified the states that your computer can be down to four: it's either off, it's in sleep mode, it's on but it's actively being used, or it's on but it's idle. And of course, again, we're using psychology, because that red idle, we wanna make that red as small as possible. We're comparing that to an energy-saver target profile – I said, earlier, we can't compare you to real people, but we can compare you to an ideal. So, the pie chart shows what the ideal level of idle would be, given the same amount of active time that you have. And that little smiley face you see, that smiley face changes into a really big smiley face, all the way down into a very, very sad face, depending on how your idle time compares to the energy-saver target. And you might think it looks a little corny, but I'll tell you from the field test, people really do not like to see those sad faces, and they really want to see the smiley faces.

So, another thing to look at is, at that top bar, you can see that you can look at this in terms of weeks or days or months, and you can scroll back and forth to previous weeks or days or months, to see how your performance has changed over time. And again, people really seem to like that. At the very bottom part, again, we can't compare you to other people, so we were a little bit limited in what kinds of other motivations we could bring up, so we're bringing up pro-environmental messages, which we know some people will respond very positively to. So, we're bringing up the idea that if you save energy by reducing your ideal time, you'll reduce pollution, it'll be similar to having trees planted, and it will get cars off the road. And for those of us who are living near Los Angeles, cars off the road is a very positive image. *[Laughs]*

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This is the second kind – here, this is looking only at idle time, and we're comparing your idle time for the day of the week this week to the day of the week the previous week. And again, you have smiley faces or frowny faces, depending on how much better you're doing this time. And again, you can scroll back and forth to see how well you're doing. So this might be for the person who was doing perfectly well during the week, but is leaving it on and finding out that the diagnosing the problem is over the weekend.

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And this is one that a lot of people seem to really like. The top bar, there, is the computer state over time. So this is showing, in this particular example, for instance, that it was off for a long time, and then it was idle for a little time, active for a little time, idle – you can see when exactly your computer is going to sleep, you can see when it's idle, you can see when the problem cases are. And you can compare it directly to that bottom graph, which is what your computer sleep settings were. Now, I'm now realizing, as I'm looking at this, this is not the greatest example, because the sleep settings – this is actually from my computer – the sleep settings are set at 20 minutes the whole time. But imagine if you had had your sleep settings set at never or an hour, and then you changed it down to 20, you would be able to see the effect that that had on the amount of time that your computer was spending *[audio cuts out]* idle, in any given time.

And again, you can look at this from different amounts of time – days, weeks, months, hours even – and then flip back and forth to be able to see. Another great feature of this is that you can diagnose problems with your computer, where your computer was supposed to be going to sleep and it's not, and we've used that a lot, too.

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And then we have a series of frequently asked questions – these are both about the interface itself and also about just in general how do you save energy, and that's just kind of a standard thing. So that's the interface.

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And now, we'll talk about how we're testing it. So, Stage Two is the field test – we're looking at desktops on UCI campus, and we're collecting a lot of different types of data. So on the one hand, we're collecting data on the actual energy consumption of these desktops in the different states, the sleep settings themselves, the computer's state – and by that I mean the off, on, sleep, and active – and the self-reports of various things. So, in the first visit, so Research Visit One, we do two things: we put Pumi on their computer in observation mode only, so it's only recording data and they can't see it; and we also install energy monitoring equipment. So we have a power strip, we plug in the computer and any monitors that are being controlled by that computer, and we have a plug meter that is giving us information about exactly how much energy it's using and its timestamp.

So, everybody then gets a one-month baseline period of measurement. At the second visit, we ask them – so, that little tablet is supposed to be a questionnaire that they're filling out. We didn't wanna ask them questions about their sleep settings in the first visit, and bias their baseline, but we're gonna ask them questions here at Visit Two, about their feelings about computers, are they an expert or not, do they change their sleep settings, et cetera. Then we also have, we break the people down into experimental group versus control group, and for the experimental subjects, we then activate the Pumi interface so they can now see it. And we say, "Hey, here's the next phase of the study – you can use it if you want to." And we're trying to make the control people just as similar as possible to the experimental people, so we open up their regular sleep settings and say, "Here, we're supposed to show you how to get to your regular sleep settings – you can *[audio cuts out]* if you want to."

And then there's a two-month period where we are recording – we're continuing to collect data on that, and seeing whether or not that changes the behavior. In the third visit, we take away all of the hardware and the software, and give them one more survey where we ask them questions about mostly how they like the program.

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So, I wanted to mention _____ _____ the hypothesis are, because the results will make a lot more sense. So the first thing is, we wanna make sure that people are changing their sleep settings in the second period instead of in the first period. We don't wanna find out that people are just changing their settings randomly _____ _____ _____ changing their settings after the second visit. Most importantly, for those people whose sleep settings are disabled to begin with, what we would like to see is if the experimental people who had the Pumi interface are more likely to enable sleep than the control subjects who just looked at their regular settings. And similarly, second point, if they already have sleep enabled, we would like the experimental people to be more likely than the control people to improve their sleep settings, so, reduce the delay time: if you had it set for an hour to go to sleep, now you set it for half-an-hour to go to sleep.

But finally, we wanna make sure that they're not doing bad changes, too. And I think a lot of times with experiments you don't look at that; you only look for the behavior that you want, and you forget to look for the behavior that you don't want _____ _____ _____ people are just randomly doing things. So we wanna make sure that they're not randomly also making things worse.

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So, the data collection and the current status of this is that we have 419 subjects who have started; most of them have finished the Research Visit Two. We have 292 who have finished the third research visit, and those are the people that we're gonna be talking about these preliminary results. So, I wanna be clear that these are preliminary results; we also have an ACEEE paper that we're gonna be presenting, and hopefully we'll have the rest of the results then.

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So, we'll start off by saying what are we starting with, in terms of whether sleep is enabled. So if you look at the first graph, there, this is whether they said that they thought that their computers or their displays were going to sleep. And we see that 63 percent of them think that their computers are set to go to sleep, and 91 percent think that their displays are set to go to sleep. And like I said before, a lot of them said they don't know about their computer going to sleep. The second one, if you look just at the blue bar, this is telling you who was actually observed to have their sleep settings enabled. So, again, 63 percent thought their computers were going to sleep; only 13 percent actually are going to sleep. It's a little bit different for the display; we have a high engagement for the display. The display is simply not a problem, so we don't have to worry about that; we wanna worry about the computer.

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So here are the big results. So, the first two, we're looking at whether there's any change in that beginning baseline period versus in the experimental period, and we're seeing exactly what we would expect: there's a lot more change between the second visit and the third visit, particularly for the experimental people – so far so good. That third set of bars, these are the people who had sleep disabled, and which ones of them then enabled sleep, and we see exactly what we wanna see: 67 percent of the people who had Pumi installed, the experimental people, have enabled sleep as a result of being exposed to the Pumi program. But we also see that 18 percent of the control people have enabled sleep, so this is actually very positive. It turns out that just people that their sleep settings are disabled encourages 18 percent of them to activate it.

And, you know, I get a lot of pushback from people about, like, "Oh, if people wanted to enable their sleep settings, they could." I'm, like, "Well, maybe they just don't know, so let's just show them to them." The fourth set of bars right there is, for people who already had sleep enabled, did they reduce their delay time? And again, we see that a third of the experimental people do that, they go from, say, 30 minutes to 20 minutes, or an hour to 30 minutes, so that's, again, a very positive result. And then the last two, these are the bad results that we wanted to not see, and, look, we are not seeing them. So, overall, this is an excellent *[laughs]* – we really did not expect to see results this good, so I am very happy with that.

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These are the same results for the display, and we more or less see the same thing. We do see, in those first two sets, that people churn a lot more for displays, they change their settings back and forth, but again, we see that the experimental people are more likely to change their settings during the experimental period than the control people are. We can't look at no sleep to sleep, because practically everybody had sleep enabled. But we do see in that fourth set that, for the people who already had display sleep enabled, the experimental group was much more likely to improve their settings and reduce the amount of time it took for their display to go to sleep. And again, in those last two, we do not see any sort of negative effects. So, overall, it looks like the Pumi is really making exactly the kind of difference that we expect it to.

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These are some self-reports about how people liked the Pumi program, so the first – this is only for the experimental, so that we can compare. The first few are looking at how friendly you think the standard sleep settings are, versus how friendly you think the Pumi program is. And it's 5.4 versus 5.0, which doesn't seem like a huge effect, but it is statistically significant, so we'll take that. And then there's a direct comparison of Pumi to standard, on a 1 to 5 scale, and we're getting 4.1, so that's, again, a very good result. So, the bottom two are to scale, so these are a whole bunch of multiple questions that we look at an average for. The first one there is the usability of the app, is the standard usability scale, and we're seeing a very positive result on that, four out of five, on average.

And then, finally, a list of the different features that they might have used, and which features they found to be particularly useful. And again, we're getting that higher than three out of four, so that's, again, a very positive result. So, overall, they seem to like the program.

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So, the rest of Stage Three is that we're looking to finish processing the results. We have a little bit of a preview that I just showed you here, but we have a lot more questions about how exactly decide the feedback change user behavior and the patterns of user behavior. We haven't even started to be able to look at the energy savings, the actual energy monitoring that we were able to do, and exactly how much energy is being used in the various states, and how much is being saved by the interface. We're also gonna do a lot more work on the feedback on the interface, both in terms of what people were using – which we have recorded – and also, what they seem to like better, and any sort of possible improvements that we could do to the program. And then, finally, this is an incredibly rich dataset in terms of what we now know about how users are behaving toward the power management features, that we hope will be applicable to a wide range of other kind of power management questions.

So, finally, I have this as planned, but, really, this is hoped, because this isn't actually part of our current grant, and we need more money for this. So, if you like the sound of this, let me know. Stage Four is we need to revise and distribute, so, obviously the software is working, but we need to update it based on the little problems that we've found. We need to create a standalone version that's a non-research version; right now, the only version we have is gonna keep giving us data about you. And then we wanna find partners to help us to distribute and further develop this. So, we're looking here at, again, a broad range of utilities, commercial, universities, businesses. Our whole idea, here, is that we got public funding to do this; we wanna make this as publicly available as possible. But we do need some help in terms of, you know, we need to manage the software, run updates, run upgrades, et cetera.

And then, finally, we are also hoping to seek funding to help develop and test versions for laptops. The development shouldn't be that hard, but the testing is gonna be a little tricky, so –

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That's it. Thank you very much, and I'm looking forward to answering any questions you have – I can talk about computer power management all night. *[Laughs]*

Rois Langner: Wonderful. Thank you so much, Michael and Joy, for your presentations. Gosh, there is a whole lot of work that you guys are doing over at CalPlug that's incredibly interesting. And if anybody listening in, the attendees, have question, please type your question in the question box, and we will respond to that.

I might start off with a question, Joy, about the Pumi system. And I'm curious if the dashboard itself automatically pops up on the computer screen, or if this is something that you'd have to actively access?

Joy Pixley: It's a very good question. So, both will happen. So, you can open up the program any time you want to and look at it, but we were especially worried about this issue that you bring up _____ do we have to activate it, because people will put it on their computers and then forget about it is the concern. So there's a weekly popup that pops up on Monday mornings and says, "Hey, would you like to look at your weekly usage report?" And you can go straight to the program or you can dismiss it, but it does keep reminding you that this program exists, and it will give you your usage report. We're hoping, for the next version, to make this a dynamic response, where it keeps popping up to show you your usage report if you're not doing very well, but if you are doing very well, it kind of gives you a break for a few weeks and doesn't keep bothering you. We're trying to find that good balance between putting it in people's faces so that they're gonna be engaged with it versus not really annoying them.

Rois Langner: Great, thank you – yeah, that is an interesting topic, and I feel like sometimes you need those popups or push notifications to keep that reminder going, with these programs.

Joy Pixley: Exactly.

Rois Langner: One other quick question that I had, too, is I really liked that you were showing the pro-environmental messages for how much you were actually saving, and what that equated to. And we were wondering if you had thought about showing it in a cost format, for how much cost savings they were saving with that?

Joy Pixley: In terms of the individual person cost savings, we had a real limitation there, because, if we're gonna make this a standalone program, what that means is that we have no idea what utility this person is using, we don't know how much they've used so far, we don't know what their current plan is. So it's actually very difficult for us to make an estimate, for that particular person, how much energy they're going to save. So, the estimates that we're using for the environmental feedback, those are pretty broad and vague, so we can kind of get away with having a margin of error, there. If we're gonna be trying to estimate how much they personally are saving, they can check that, and if we're wrong, then they might – that might actually be worse, to give them a wrong answer than to give them no answer on that at all.

Rois Langner: That's very true. Some of the incentive programs that we've seen, where companies are providing incentives to either tenants or individual employees for meeting energy targets for plug loads, et cetera, do involve some sort of financial gain. For instance, GSA, with their tenants, in one of their buildings – the Wayne Aspinall Federal Courthouse building, it's in Grand Junction Colorado – _____ _____ energy-building, and if they meet their target or come in below for their plug load energy, then they get a percentage of their rentable square footage fees back. So, that's where this financial question comes into play, too, and if we could use some of this data to infer, or the individual tenants could apply some sort of cost value to it, then that might help them to realize whether their tenants or individual occupants are actually meeting those targets, moving forward. *[Crosstalk]*

Joy Pixley: Yeah, I think that's a great idea, but the concern that we have is that, again, we don't really know how much the person is paying for electricity. And we don't know how much that particular computer uses in idle mode, because we're finding that the computers really differ from one to the other. But, yeah, we could certainly have estimates, which would be very useful, I think, in a macro sense.

Rois Langner: Wonderful. Marta, do you wanna jump into other questions that have come on the line?

Marta: Yes, I would love to – we have a couple questions in the queue, and I'll go down the line on these. This first one is, regarding to CalPlug and your work with tier-two advanced power strips – I believe, Michael, you spoke to that a little bit early on, when introducing CalPlug. And so, this question is specifically regarding that, and it is this: What type of residential or commercial tier-two APS – advanced power strip – projects has CalPlug worked on with utilities? Are there any results published that you can share?

Michael Klopfer: Yes, there are. So, we've been involved, back since 2014, setting up the initial field trials in California; they were put together with San Diego Gas and Electric. The second part of that field trial was sponsored by Pacific Gas and Electric, but happened in the San Diego area. Both of those are reports that were published by an energy firm, AESC, and distributed through the manufacturers – you can find them on a Web search, so they're available out there. In addition, we did a review of protocols used during field trials, and presented this at a conference this summer, the EDOL conference – so this is available as a CalPlug paper, as well. So, there's three different ones on this. The area, so far, we've focused on is residential AV applications. *[Brief silence]*

Marta: Thank you, Michael.

Joy Pixley: Michael, are those located on your website, too, those resources?

Michael Klopfer: The two, actually, I believe through our tier-two APS portal. So, tier2aps.calit2.uci.edu is the tier-two qualified product list we put together as a collaborative project with Pacific Gas and Electric – they are shown on that particular site. So, again, that's tier2aps.calit2.uci.edu.

Rois Langner: Thank you, wonderful. And if folks are interested, we can send that out after the webinar, when we send along the slides and the link to the recording, just so everyone knows.

Michael Klopfer: Perfect.

Rois Langner: We have another question on the list – this one's back onto the Pumi project, and this is just kind of regarding barriers in potentially understanding the users of this project. So the question is: Based on the Pumi project, do you think that one potential barrier is that people don't understand the difference between idle and sleep? To what extent do you think this understanding plays a role?

Joy Pixley: That's actually a very good point. I think they don't really understand what sleep mode means, but I think the larger problem that we're running into is that they can't tell the difference between the monitor going to sleep and the computer going to sleep. So, *[siren sounding]* –

[Side conversation]

Rois Langner: No worries – thank you, guys. We're almost at the top of the hour anyways, so we'll wrap this up. We really appreciate it, Michael and Joy, for your time, today – sorry, you are in the middle of a fire drill – you should go exit the building immediately.

Joy Pixley: We are gonna go exit the building, immediately. Thank you so much – bye-bye. *[Laughs]*

Rois Langner: Thank you, bye.

Marta: Thank you, everyone.

Rois Langner: Hopefully it's just a fire alarm for those guys, but we have to follow the rules. Okay, great.

_____, can you please skip to the last or the next slide, here?

If there are any additional questions for Michael and Joy, please e-mail us – our contacts are on these slides – myself, Kim, Marta, or Suramei, and we will put you in touch with Michael or Joy, to get responses to your questions as soon as possible. And with that, if there are any additional questions, comments, or member updates that anybody has and would like to share, please type that into the question box, or you can e-mail us at the end of this call.

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And with that, I thank you all for joining, today. I hope you found this information useful, and we will keep you posted on when our next team call will be, which will be scheduled in about August or September of this calendar year. And thank you, again, to our technical presenters here, Michael and Joy, for their contribution and for teaching us about CalPlug services and what they do. And looking forward to meeting with you guys all, soon. Thank you so much. Take care. Bye.

Marta: Thanks, everyone. Bye.

[End of Audio]