EPIC POLICY+INNOVATION COORDINATION GROUP

TRANSPORTATION ELECTRIFICATION WORKSTREAM – MEETING #1

SEPTEMBER 30, 2020 10 AM – 11:30 AM

Welcome everybody. I would like to thank everyone for joining us today to discuss an important topic that is critical to the decarbonization efforts in the state of California. My is Andrew Barbeau. I am the California Public Utilities Commission's consultant for the epic policy group. Before I get started, I want to cover a few ground rules for today. Again, thank you for joining. If you're having technical difficulties, audio or video problems, please contact Amanda Fornelli . All participants will be muted on entry. There are some panelists and some staff that will be un-muted when the meeting begins. If you need to pose a question, when we get to the Q&A portion of the meeting, you will see a Q&A picture on the right-hand side of your WebEx screen. If you do not see it there, it may be on one of the buttons on the bottom right-hand side, or behind three dots on the far bottom right corner of the screen. This meeting is being recorded, and will be available online at www.epicpartnership.org after the meeting. We have a live transcription feature for the event. That is in the multimedia box on the right-hand side as well. If you do not see that, please click on the multimedia button in the lower right-hand corner. It might be behind those same three dots on the far bottom right corner of the screen. Again, the transcription and translation will be available after the meeting at www.epicpartnership.org. You can also find the link to the live tarnish translation in the chat box.

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Let me cut the video off really quick. My name is Andrew Barbeau again. President of the accelerate group. We are the California Public utility commission's consultant of the EPIC coordination group. We are working with the energy division of the California Public Utilities Commission. And the role overseeing the EPIC electric program investment charge. The Electric City research and development program at CPUC. That the CPUC created back in 2012. The recently extended it to 2030. The CPUC launched the EPIC policy earlier this year. Together insights and lessons learned from EPIC electricity research development and development projects in the state. And to identify new opportunities for collaboration and to accelerate innovation. The EPIC policy and coordination group is coordinating four work streams in 2020. In areas that are determined to be critically and timing for. Equity, transportation electrification, wildfire mitigation, and public safety. Before we begin, I want to acknowledge the other policy and innovation participation group participants had adjoining today including the EPIC of administrators. Staff and advisers. The utilities PG&E and others. Staff, commissioners and advisers. Today, we are launching the transportation electrification workstream. Some of you were able to join the first meeting of the wildfire mitigation workstream that we held last week. We will also be launching the equity workstream next week. You can find more information about all four workstream's at www.epicpartnership.org in my role as project coordinator, we are working with the CPUC, CUC, and program administrators to identify speakers and presenters that can share insights on these pressing topics facing California energy policy. And to organize and facilitate these work streams. I will also introduce Rebecca Goold and Amanda Fornelli. If you have any questions, please reach out to us.

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So again, today we are here to kickoff the transportation electrification workstream. The overall goal of the Transportation Electrification workstream is to discuss questions raised by the VGI working group and the CPUC's transportation electrification framework on technology, regulatory, and market challenges to transportation electrification development. And gain an understanding of the cost-effectiveness of different approaches. In workstream, and transportation electrification, we will conduct three meetings between September, today, and December, 2020. Today's meeting will focus on EPIC and other projects that can buy a bride insight into the role. Particularly around fleets, medium heavy duty vehicles or clusters of electric vehicle charging infrastructure. And management systems have been proposed as a solution to manage customer charging load to avoid utility service upgrades. The electrical capacity upgrades and a whole site. And other VGI use cases.

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We have several good presenters here today to talk about their research and ongoing work. We have at Pike from the CPUC. A senior utility engineer at CPUC. We have Zach Lee from PowerFlex Systems. We have Hitesh Soneji from Olivine. We have Thomas Ashley from green lot. Jordan Smith from Southern California Edison. And Lydia Krefta from PG&E. After those presenters give a short presentation, we would do a panel discussion and a Q&A. Where participants will be able to pose questions and have a discussion to panelists and others. We will wrap up and talk about what is next at our next meeting.

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We have asked these presenters today to address some, or all of the following core questions and their presentations. First, how can utilities and customers incorporate an electric vehicle energy management system when determining the need for a utility service connection upgrade? What barriers would prevent customers from adopting energy management systems as a non-wires alternative to physical upgrades? And what information is needed to evaluate the potential to use electric vehicle energy management systems to manage concentrated loads, such as medium duty/heavy duty loads, to avoid a utility distribution system transformer or feeder upgrade? The presenters, hopefully will keep their presentations short. If you have questions for the presenters, please include them in the Q&A feature on the right-hand side. We will try to get as many questions as we can in the 30 minute Q&A session after the presentation. Please note, that one or more CPUC or CEC commissioners and advisers, may be attending today's meeting, but no official commission action will be taken at this event. As a reminder, if you have technical difficulties, please reach out to Amanda Fornelli . If you have questions, please use the Q&A feature on the right-hand side . You made you to click that Q&A button on the far bottom right corner. It might be behind three dots. This meeting is being recorded and will be made available online at www.epicpartnership.org after the meeting. I want to click it over to Ed Pike, who is the senior utility engineer with California Public Utilities Commission. Ed?

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Hi, thank you, and her. Thank you to your team for all of your hard work organizing these workshops and also thank you to the EPIC team and the energy division at CPUC for helping us tackle some really, I think important and challenging issues around vehicle grade integration and transportation electrification. I'm really excited to hear from a really deep roster of experts at this meeting. Both the presenters, but also the folks that are not presenting. I think there are a lot of folks here who also have a lot of great experience to help answer these questions. I really very much appreciate everyone's engagement and

look forward to your active participation. Energy management systems was at the heart of a number of recommendations that came out of the vehicle integration working group. Thank you to many of the folks here today for your participation in that working group. The final report was a huge on June 30th. Now, the commission needs to turn all of these good ideas into action, along with all of our partner agencies and stakeholders. Our actual income enters on the ground. We are required to issue implementation strategies and metrics and other topics by the end of this year under Senate Bill 676. We have also addressed some VGI related topics in the draft transportation electrification framework. You should all have a link to that now. I believe Andrew sent it out recently. I think there's a lot of opportunities for us to move forward on vehicle integration solutions. I'm really looking forward to hearing about some of the use cases that were mentioned by stakeholders in the VGI working group, and parties and comments on the records with Public Utilities Commission. Just to rid rate what Andrew said, some of the use cases that have been brought up to us are avoiding utility distribution system upgrades. What I think of as the feeder level. I'm not so much an expert on the distribution side. Host site could potentially solve charging more quickly. More economically. They can avoid any further utility service upgrade, or for on-site electrical system upgrades. By using some type of system to manage their on-site charging load. There were a number of other use cases that were identified as well. Certainly, these aren't the only possible use cases that have been brought up to us, but I'm really glad that we will be focusing on those today. So again, I look forward to learning more from everyone at this workshop today. Thank you so much for all the panelists and all the participants.

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Thank you, Ed. I want to kick it over to our first panelist today. That is Zach Lee from PowerFlex Systems. Welcome, Zach.

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Thanks. Great. So, hello everyone. My name is Zach Lee. I'm a software engineer with a focus on algorithms for PowerFlex. I'm also a student at Caltech. I'm excited to share with you all today our work on using charging management as an alternative to costly infrastructure upgrades. Mostly around nonresidential charging, and with a focus on large scale charging systems. Next slide. To provide some context about power flex, we have installed around 3000 EV at over 100 sites over the past 4 1/2 years. We are also very proud to have delivered over 2 million miles of electric charge using our charging algorithms. Next slide. Here we can see a couple of our sites. Deployments. Many of our sites have over 50 managed level two chargers, with a mixture of fast chargers and on-site solar generation. Next slide. Our customers really run the gamut from universities and research institutes, to municipal governments, workplaces, multiunit dwellings, fleet charging. All of these stakeholders really benefit from managed charging. Next slide. So, just to get us started, I would like to show this little cartoon example. Really, what managed charging allows us to do is just do more with less. On the left here you have conventional charging. We have a power limit of 12 kilowatts. We can see that with kind of conventional unmanaged charging we are going to overload that limit. But, with adaptive or manage charging we can meet all of those EV's demands while staying below the power limit. That power limit could be a transformer limit. It could be your utility service limit. The capacity of a line, anything like that. Next slide. I think it's helpful to kind of go through a sample use case. Here we have a workplace that needs to charge around 100 EV's a day. They have a couple options. We can install Level One charging. In which case, we can install 102 ports. That would require around 200 at capacity. We can assume maybe they have that

much headroom on their existing service. However, from our dating on workloads, it would only serve around 75% of demand for a workplace site. We could instead install unmanaged level two charging, but if we install the same 102 ports, now we are going to need 600 80 kVA capacity. That's going to require us to upgrade our service, which is expensive. We are also going to incur really high demand charges. The way people get around that normally now, is by maybe only installing 30 ports, and then asking users to watch their vehicles throughout the day. That is really not a great solution. That brings us to what we think the future is, which is adaptive or managed charging where we can still install 102 ports, and still meet everyone's energy demands, but we are still doing that within the limits of our existing infrastructure. As a side benefit, because we are optimizing, we actually see a reduction in cost of energy as well. So, next slide. We will move on to the next slide as well. So, this is a case study from a real site that we recently brought online. We installed 168. If you just add up that main capacity, it is over 1 1/2 megawatts. However, the existing panel only had around 530 kilowatts of excess capacity. So, we used managed charging to stay within that capacity, which allowed us to avoid any kind of interconnection upgrade and the associated costs and delays. What that allowed us to do was install the stations for less than $3000 per port. Which if you compare that to publicly available data from other projects, it is somewhere between 10 and $15,000 report. The significant reduction allows us to install more ports for the same investment. Next slide. We are also able to do demand response. We have demonstrated this on real sites. In fact, last month during the heat wave, we were able to dynamically reduce the capacity of many of our sites to help reduce the risk of public safety shutoffs and things like that. Next slide. Also skip this one for the sake of time. So, that brings us to kind of the challenges we see. Reality, we think education ends up being one of the biggest ones are run into on a day-to-day basis. On the user side, users are really used to plugging in their cars and charging it as quickly as possible. For managed charging, we need them to trust our algorithm and our scheduling, that when they tell us they need a certain amount of energy by a certain time, we're going to get that. They can relax and let the algorithm do its work. On the other side of that, we have to educate the consumers that there is a benefit to them. In terms of their more ports so they are not swapping throughout the day. They are paying a lower cost of energy. On the other side, we see permitting being another thing that we sometimes run into issues with. Educating local permitting officials. Managed charging is safe it and is safe within the existing electrical codes. Next slide. What is the information that we need to make the stuff a reality? I think Vicki really comes down to having high temporal and spatial resolution of the data. Existing programs with blanket time of use Yates, or blanket demand response, didn't get us down to the level of an individual Peter. When we have multiple of these large sites, on a single feeder, we we really need to be very granular. Ideally we would love to have detailed feeder modules, high-resolution data both in real-time and historically so we can manage charging with utility and avoid infrastructure updates. Barring that, just having safe operating envelopes that are specific to a feeder and a particular place in a feeder. That would really be helpful to avoiding those infrastructure upgrades. At the distribution level. Finally, having workload information for how a charging system is going to be used is key to understanding its effect from the distribution system. Towards that end, we have released we'll find brand charging data from three of our sites. We think this is really valuable and would encourage others to do the same. So that we can kind of all be working off the same models of demand. So, with that, we can go to the next slide. I just like to thank you for your time. Feel free to reach out to me by email, and I'm looking forward to the Q&A later.

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Thank you very much, Zach. I want to move -- I have got to get past him. Go over to Hitesh Soneji from olivine. I keep getting it wrong I think. He will present on their California integration project.

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Thank you, Andrew. Hi, my name is Hitesh. I am in engineer for Olivine. We are a distributed energy and resource management firm. We do quite a bit of work helping utilities administer programs. As well as a scheduling coordinator. I'm going to focus on our project [Indiscernible - muffled] there were two projects that focused on electric buses. Next slide please. So, the goal of the project was really to implement VGI on a fully built out public transit electric fleet. They really bought into the idea early. We did have some challenges. The fleet operations schedule, the fleet buildout was kind of delayed. The hardware and software on the ground didn't actually do the level of dynamic control we wanted. I'm happy to go into any of those details with anybody off-line. So, what we focus on for this project. Really innovation and energy modeling for the fleet. We had a minute by minute simulation on where we could model an entire [Indiscernible] its energy use, it's movement, when it charges, etc. It is super configured to. The reason I bring this up is I think it's part of a full energy management solution. We'll get to some of the points I'm going to try to make later. We leverage that energy model to then do evaluation analysis on different VGI scenarios. I'm going to discuss those in my next slides.

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So, primarily we came out with the result that the most valuable thing that can come from a VGI model, is smart charging. I think that should come as no surprise to this audience. Here are a couple of slides that just demonstrate a number of different charging strategies. We call the yellow line dumb charging. A lot of people end up doing that. The medium and heavy-duty industry hasn't figured this out yet. It isn't actually a high priority for many of them today. The challenge of electrification is such a big hurdle that energy management is kind of a second thought. I will get to that in some of the later slides as well. You can see here clearly, there is a great opportunity for financial savings, this is primarily in energy costs. For the fleet. Next slide please. We also did look at demand response. What you will see here in the dotted blue line is that you will get a snap back. Especially in heavy-duty fleets where you are really time constraints. You have a massive capacity of units that need to be charged in a pretty small time window. You're operating from 5:00 in the morning until 11:00 at night. That small window makes it hard. You're going to have a snap back that is going to basically push the power envelope up. That's kind of contrary to some of the goals we are talking about here. So, it may not make sense to really be using a medium or heavy duty flute as a sort of traditional resource. Both financially as well as from an infrastructure perspective. Next slide please. So, getting really to those three questions that Andrew presented at the beginning. How can energy management systems have an impact? Here is some of our insights from this project as well as a number of other projects. The system needs to be a system as well as a service. It needs to be involved in the project early. We need it to be involved in interconnection. If the EMS system and it sort of modeling and services aren't involved at the interconnection, you can't make any of the savings we are talking about just happened. That modeling, or the EMS service if you will, needs a reliable [Indiscernible] it needs to do it was so much confidence -- I'll buy that. I'll let you impact at this [Indiscernible] which is well below if I multiply 100 chargers out. That confidence has to be there. Zach, I think you alluded to this a little bit. I think one of the big challenges is how do we get that in the energy management system so that there is low risk to the load serving unit? In terms of infrastructure updates, I think transformer upgrades are just going to happen. They are going to be a

requirement. If you look at most of these areas, the infrastructure there is just to provide air conditioning load and maybe a couple compressors for a garage. That's it. We're talking about 250/500 kVA charges. I think a transformer upgrade is going to be necessary. A feeder upgrade I think you might be able to avoid. This is where I think the EMS can have a huge impact. Then again, it's not just EMS, so the project planning services. One of the other lessons we really learned is you need a system integration team. It is helping them make resilient technology choices. Hardware, software, vehicle, charging. All of this. Especially when you think heavy-duty space. Next slide please. The topics on the left ear are more about do you need an EMS? Of course you do. What information do you need from that EMS? For medium and heavy-duty fleets it's really about the duty cycle. Understand their duty cycle. Let's go to the barriers. I think these are more interesting. Systemic barriers. I think the demand charge holiday was a great idea. I'm not sure it is getting us to the place where we want where people aren't thinking about managing their energy. It is giving them an opportunity to not worry about it. I understand because when you only have a handful of vehicles, and you only charge them in a sort of repeat pattern, the demand charge is extremely tedious. Once you get to a fleet of 300, and you have an energy management system, [Indiscernible] I think the demand charge at that point that point starts to fade a little bit. I think demand charges are a reasonable tour. Our work also suggests that the subscription model that PG&E has put out is also a very reasonable tool. [Indiscernible] a slightly different arrangement. My colleagues can speak to that. In addition, there is the whole infrastructure barrier. [Indiscernible] I think in these early stages, the EMS has not been a priority. The big concerns are let's get this thing working. Two other things I think that could plan for this. Emergency charging concerns. What if I have my interconnections are set it limits my ability to respond in a critical situation? I just need to get this thing back up. Something goes wrong. Maybe there is a natural disaster. I think a lot of the medium and heavy-duty sector folks are risk-averse. They are concerned about that. That connects also into the arranging cycles. Next slide please. I'd love to hear from any of you if you have any questions. Feel free to email me or call me. Thanks for giving me an opportunity to share our results.

Thank you very much, Hitesh. I want to jump right into our next presentation. I see we have questions coming in. A reminder, if you have questions for any of the panelists, or comments, please raise them in the Q&A box on the right-hand side . It might be behind a button on the far bottom. We have some coming in. Please share along the way. We will get to them in the panel discussion at the end. I want to move over and shift over to Thomas Ashley from Greenlots to talk about some of their managed EV charging efforts.

Thanks, Andrew. Hi, everyone. Tom Ashley, IV policy and market development for Greenlots. If you are unfamiliar with Greenlots, we make software that manages electric vehicle charging and work with our clients and partners to help provide full deployment of infrastructure. So, we can go to the next slide. A lot of the discussion here is going to be kind of in the context of managing decent fast charging with integrated software management, as well as to some degree, storage. A lot of this will pick up very cleanly on the messages that Hitesh and Zach have shared. First, for all of you just a quick reminder. Via visual of what this project vision was in its development. With a little helpful diagram here. I would share that the high level here is the deployment of four fast chargers with integrated Second Life storage and then we have a combination of software management via Greenlots which includes

interaction with a physical site controller. That we use for load management and communication with, in this case, the battery system. So, that said, I would share that this project vision as bulleted on the left has proven to be rather aggressive. This project overall has been a very interesting process to see what this looks like to put all these pieces together and breathe into the real world. I think a lot of us have this experience in our labs, and feel very confident, but it is a different ballgame when it is brought out into the real world, with real drivers. Who may or may not know that something is happening here other than just regular old charging. So, that said, we can stick on this slide for a bit. So, at the end of the day, we have had to move this project, which was a bit of a challenge, and unexpected. So, the original project location in Monroe via ended up being sold, so this project was effectively under lease there. We had to move everything and find a new site, which we ultimately did, if you can go to the next slide. In Monterey Park. Which, if you're not familiar with Southern California, is about 10 miles east of downtown L.A. So, we have ended up deploying this project with four cast chargers and integrated Second Life Nissan Leaf battery storage system. I would also share that in the challenges department, we have not seen very much usage of this site in the COVID era. There has definitely been a significant diminishment of EV charging activity in the COVID area. This is a site that I think a lot of drivers didn't have cause to become familiar with. Just from a user standpoint. It is located in a sort of shopping facility off the 60. But, this project has really helped Greenlots and myself , from a policy standpoint, reinforce a lot of our experience and expectation of both the importance of managed charging, as well as indeed many of the challenges and barriers that we continue to see. I'd like to go to the next slide. So, really have some bullets here. I'll share some additional messaging. These are, in large part, in response to the first couple questions of how can we better leverage nine wires alternatives, and really what is standing in the way for us to do that? So, I want to per-share kind of in the context, or through the lens of already existing, or already approved. I owe you easy charging programs, which certainly have accounted for a significant number of physical charger points in California, including around the geography of this project. So, some of this may be a little wonky for you all and may be a non-technical manner actually. We've seen a lot of functional challenges in the way that these programs are either designed, or ultimately, the way that they are implemented following the regulatory process. And in some cases, commission evolution of the original program vision or design. So, what tends to be the case now, is that utility rarely has what seems like a clear opportunity to help facilitate a lot of these things. So, whether that is to provide customers very easy options, or for program participants, very easy options. For education on different methodologies for managing EV charging. Whether that is bring a nine wires alternative, including a battery system, to the table. There are a couple pieces here. One is quite simply, we, in California, have largely limited the ability for the utility to only an asset, the charging station itself, and the equipment associated with that. That is behind the meter. Or, at least on the charging pad. So, that tends to position the program participants as the decision-makers for that equipment, as well as the software and the software related management. To be frank, most of these program participants are not very sophisticated buyers or planners in regard to energy or site management. So, we've created really a very sort of decentralized decision-making system for the software, for the equipment, etc. This is a really significant challenge. A lot of this has really kind of stand from I think some misunderstandings and misperceptions about the types of business models that exist for deploying EV charging products and services in the industry, as well as the role that utilities can play as clients, partners, facilitators, funders, etc. What I would also share, and you heard some of this from Zach as well. We really have, in some cases, they are actual either program requirements or contained with an extension policy. Or, they are just the way we have all been socialized to deploy

electric -- Electricity capacity. We tend to do that and not allow for more potential power draw from let's say charging stations than what a facility is certified at. So, every time basically means that we are paying for more capacity than we need to, and we are paying for physical things, rather than software or potentially on-site equipment that can limit the necessary draw in and manage that. These are very fundamental elements of the electrical system and the way that utilities, contractors, etc. tend to do business. Part of that, I do want to flag, both in relation to some existing EV charging programs, as well as in-line extension policy language more generally, is that there tends to be basically a expectation, or indeed a motivation, for property owners who have just benefited from joining a program or having capacity or line extended to the property, to then have to use a certain amount of load over time. Or, pay the difference to some degree. So, we have basically set up a system where those users are incentivized not to manage, in this case, charging, or in other cases, other types of resources or use cases. So, I think there is really a lot of opportunity for us to think seriously about how we approach this, which is engaging in more non-wires alternatives. Physical upgrades. I think there's a lot of opportunities. I also want to just communicate, at least from my policy perspective, some of these are pretty fundamental pieces of existing programs and policy. So, I think it will require an all hands on deck effort to approach. Then, maybe I'll just close with the slide I was still on.

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You are a few minutes overtime. Last comments, last thoughts.

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Thank you. I also just wanted to share again, on the user front. The program participants front. Folks who are purchasing hardware, software etc. I'm for sure, a lot of these folks are really just trying to transition to electrification or provide charging solutions to their employees or their customers. They are not sophisticated in thinking about energy management systems. They are also very focused on near-term or upfront costs. Not focused on longer-term benefits. So, that again, is an area where we have I think, is a stakeholder community, and as a state, a lot of opportunity to really engage utilities and repay investment more where we can balance that long-term benefit with upfront costs. In many cases, make the upfront investments needed to unlock the long-term benefits that I think so often don't otherwise happen. So, looking forward to Q&A, and thanks for your attention today.

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Thanks, Thomas. We are going to move quickly onto Jordan. To make up some time hopefully. Jordan Smith with the Southern California mission.

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Okay, very good, thank you. So, Jordan Smith here. I'm the consulting engineer was Southern California Edison. Grid technology. Specializing in grid edge integration. You can go on to the next slide. So we actually have, in our current third tranche of epic projects, we have three projects that are highly focused among transportation electrification. I just list them here. The first one being service center of the future, which is a large fleet electrification project focused on controls, energy management systems, integration storage and building electrification. The second project is a dedicated vehicle to grid project with both light and heavy duty elements. The third, which I'll talk about more today, is a project called distributed charging resources. Which is a bit of an engineering speak attempt at

describing a fairly unique configuration of some, and elements. Basically batteries with fast chargers and a management system, emergency management system, but operated in such a way that is pretty unique, certainly for Southern California Edison. We have also been collaborating with automakers, as many of you know. We have a long history, decades actually, working with automakers on advancing electric vehicles, charging systems, and batteries. So, we continued that over the years. There is quite a lot of interest with the automakers, and the potential for Second Life batteries and stationary applications. That's incorporated here. Go to the next slide. So, just to set the stage here. I just have a couple of graphs just showing some examples. Some visual examples here that you should be a common knowledge and interest to the speakers and the audience as well. It just very well illustrates here, the grid impact, sort of scaling with power level of charges. Charges. We have seen in the marketplace, which was not unexpected, sort of a trend to higher powered chargers. Focused on the customer benefits, potential benefits, and this always depends on the use case of the customer of course. But, the potential benefit of faster and faster charge times. So, is not always the case that the customer needs faster and faster charge times. But, the market continues to go in this direction. So, the question is, what can we do with controls, energy management systems, storage, those types of things, together with the characteristics of the customer behavior, to manage this impact? So, kind of get better at delivering that quicker charge when it is needed by the customer, but yet managing the grid impact. So, you can see here, especially with the highest power indicated here, the 250 kilowatt example. It is at that very high power level for a very short period of time. So, if it shows it's amenable to using things like energy storage to sort of cap that off at a lower level, which triggers less work to be done on both the grid and customer side as well as infrastructure. We can go to the next slide. It just illustrates some examples of charging behavior. It really is charging behavior that, and this is basically what you're seeing here, is different. These are samples from our charge readying program for different environments basically. Or electric vehicle charging. We are showing here just a snapshot of workplace charging and upbeat charging examples. So, charging is driven -- We've done a lot of -- We have data scientists working on other aspects in the residential sector, etc. Looking at understanding they charging profiles of EV's. It is really driven by human behavior. How often do people plug a vehicle in and charge it? So, lacking any kind of controls, it just looks like the human behavior. We know that there is a lot of flexibility here, and that we can use energy management systems for example, to manage that. To reduce costs, reduce grid impacts. You can go to the next slide. Just a little background on energy management systems. We've actually done a lot of work in this area. Some of the background here, I separate these systems into two categories. The type I systems, and the type to systems, and the primary characteristic defining the two systems is that one does not exceed the infrastructure capacity. In other words, all the wires and switches and everything is sized for the absolute maximum that the load could generate, which is, as some of the other speakers have said, is traditionally done through a large scale. Done in most all projects today. It is really just very novel to get into the second type in which the connected load on paper, using traditional means, actually exceeds the capacity of all of the wires and switches etc.. So, the only thing that keeps that system from sort of getting into a dangerous potential condition, is a control system. So, this is relatively novel as I say here. California electrical code really enables such systems starting in 2017. In our charge ready infrastructure programs, which I'll get into, there was sort of a lack of developed standards to kind of move forward into traditional methods for installing infrastructure. Zach has mentioned this as well. Not being familiar with such systems, the certification, the standards not being in such a state that people can just see that stamp of approval and just sign off on it. So, we basically had to develop our own assessment method in order to incorporate those systems into our

charge rating program. So, we'll go to the next slide. It talks a bit about the procedure that we used to approve such systems in our program. Lacking the sort of universally acceptable standards and associated methods. So, the traditional evaluation of such systems, I think is familiar to the folks involved here. In this session, and with the panelists especially. The less improvement you need to do to the infrastructure reduces the cost. If you're going to invest in a lot of infrastructure, then you are really looking at electrifying as many miles driven as possible. At the lowest cost. So, there are some standards emerging. There are some standards work that we used as part of our evaluation process. One being the UL 916 standard which is when we focus on system that can manage energies. So, devices that can switch on and off energy. That sort of thing. There's a relatively new standard coming out of CSA. So, still a lot of work needs to be done to develop these standards and get them deployed out into the states. As I said, for, it can be a well recognized thing that utilities can look at and sign off on and say okay, that is an understandable certification, and we can design the system in accordance. So, lacking that, we had to develop some specific methods here. So, in the lab we looked at various functions and did testing. Making sure that any disruption of the control system would not result in an unsafe situation. Finally, the most important piece, which really needs the most attention to getting addressed, is the site commissioning piece. All of the existence need to be configured for a particular installation. Until that system is configured at the actual site, and the settings, or the controls, are proven at that site, we are really not done. That is where a lot of work needs to be done with standards. Until then, you have a lot of sort of engineering involvement with utilities. Next. So, we will talk about the DCR project. Distributed charging resources. Again, what we are doing is combining energy storage with charges. We are using that control system to manage that impact of that charger. We are doing so from a utility perspective, so that control system and that energy storage system is owned and operated by the utility such that it can use not just for traditional sort of customer side impacts, but we can use it for grid support. By connecting that charge control system with our grid management system. So, we're going to develop some recommendations that will show how this can be done. What needs to be done. The proving out of the control systems. Back one more slide. I'm not going to spend a lot of time on the use cases. We are going to spend time developing recommendations for how this can all be done. We are going to have data that is going to show how we are going to provide these benefits. I will say that this particular project is supported SCE, one of our strategic objectives which is to improve customer energy choices, remove barriers to adoption of transportation and building electrification, and supporting standards as I mentioned. Finally, the last slide just shows a system diagram and some use cases that we will be demonstrating through this project. Which I won't go through. You can read them here. Demonstrating the various functions including resiliency and the control system here. Which is we call the charging management system. Next to our SCE grid management system. We are able to manage this system for the benefits I mentioned. That's all I have, and we look forward to the panel discussion.

Thanks, Jordan. We have our last presenter. [Indiscernible] Lydia, are you ready to go? I cannot hear you, Lydia.

I had to double unmute on WebEx again. Hi all, my name is Lydia Krefta. I am a manager of our regulatory compliance and pilot steam. So, as we are talking about these energy management use cases, active measurement of energy is really foundational to in labeling a lot of use cases. I'm going to present

on PG&E's testing accuracy of a third-party metering. Then, I'll briefly preview an upcoming pilot that we are kicking off in 2020 focused on utility submetering. Before we get into the pilots, first just a brief overview, or reminder of what is a sub meter. So, submetering occurs when a second meter is installed downstream of a maximum. In the case of a EV, it is typically used when talking about metering EV's downstream from the main facility meter. EV's can also be separately metered. This is when you have a set of EV 's or chargers that are served separately by the grid. It has the potential to unlock a value stream by enabling us to understand the behavior of EV or charger at the more granular level. And to incorporate EV Pacific charging into customers utility bills. Some of the basis that PG&E has included enabling EV specific rates. Participation in accounting. Go to the next slide, Andrew. Metering can be potentially achieved with a utility meter or third-party or nonutility meter. [Indiscernible] could receive accurate revenue grade data that enabled residential customers to access EV rates. Those are typically reserved for customers that have separate utilities from a residential standpoint. We can do these in three phases. Across the IOU's we have found the data to be accurate. Wi-Fi tended to be unreliable to transmit data. Several accuracy issues were identified. We were unable to get more than 10% of the sub meters to test within the accuracy thresholds. So, the results of this study were that third-party sub meters were unable to provide the reliability and data accuracy required. Sub meters can be embedded and owned by a third party, or owned by the utility. Both sub meter ownership configurations can be leveraged and should be evaluated from the perspective of overall accuracy. Total cost to utility ratepayers. If you can go to the next slide please, and her. In 3.27, which will be kicked off The Shoe, PG&E will be testing a utility embedded meter. We promise our next-gen meter. A next-gen meter is a utility grade plug and play meter that can fit into energy, any energy consuming or delivery device. It packages a lot of computing power inside a small package. PG&E hypothesizes that will allow utilities to meter use up charging stations more easily. Next slide. So, this is just a rendering of what the meter looks like. You can see that it is like pretty small and can pack quite a bit into this meter. Next slide. We plan to test this meter in our upcoming EPIC pilot. In 2021, we will be testing the ability to develop a utility grade meter that can be easily plugged into a level two charging station. In the interest of time, I'll move it along. PG&E is testing many ways to enable customer EV energy management. We are working with Pittsburg unified school district to test the ability for [Indiscernible] we are working with the San Joaquin regional transport district to understand how batteries can impact charging needs and costs. As we learn more and unlock new ways to encourage energy management systems, particularly market interpretation, it's in court and to have accurate records of charging behavior. We'll continue to investigate the most accurate way for participants and nonparticipants to actively manage this.

Excellent. Thank you, Lydia. Taking one for the team. I appreciate the brevity of that. Just a little plug as well. If you want to hear more from Pittsburg unified school district they will be presenting at our equity workstream meeting on Tuesday. We will hear directly from them on some of the projects that are happening there. I want to thank all of our panelists for the presentation. We want to move over to the Q&A session here of our discussion. I have a few questions that we have gotten in already to kick it off. But, if you do have questions for any of the panelists, if you are an attendee, please enter them in the Q&A function on the right-hand side. There are lots of good questions that we are going to be talking about shortly. If you are a panelist, or one of those that has a panelist link, that is able to talk to the raised hand function, I'm going to get to that section to ask a question. I'm going to start us off with a question around costs and scale. Maybe we can start with Zach or Hitesh. What are we talking about

here in terms of scale of opportunity or value? What are the costs typically of energy management systems as they are deployed versus the savings you can get from proper management or avoiding system upgrades? I don't know if Zach or Hitesh wants to start there, or if anyone else wants to provide input as well.

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Sure, I can try to take a stab at that. I don't get too much on the business side of how much we charge, so I can't get too much detail on that. I will say in terms of reducing capital outlay costs, in terms of the savings from avoiding infrastructure upgrades and things is generally enough to overshadow any additional costs for the compute. To put on site. Similarly, I'd say for when you're optimizing and reducing demand charge. Optimizing time of use rates. You're able to more than pay for any networking fee. A key thing that we try to do is avoid networking to every individual. That's because we generally install hundreds. So, we consolidate the communication so we only need one data connection. I think that's a key as we try to scale these things out. Try to communicate that each one via cellular or something else is cost prohibitive in terms of meeting a data connection to everything.

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It's an obstacle. Data connection.

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Yeah. I'd say so.

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Hitesh?

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We did quantify some statewide savings. Again, this is mostly focused on the energy savings from doing smart charging or managed charging scenarios. For the public transit fleets, we estimated a $50-$70 million savings statewide. Just a managed charging. The cost of actually deploying that management and infrastructure is going to be orders of magnitude. As most of the panelists have been talking about, either your deploying physical infrastructure solutions, or a software solution. The software solutions are always going to be [Indiscernible] if we extend an analysis out to other medium and heavy-duty stakes beyond public transit, the numbers get even bigger. About $250 million a year or so in energy savings. I also agree with Zach about the cellular piece. They can add up. We also are involved in a project, where we have deployed something very similar. There is only a single point of communication that then controls a bank of nine charging ports for their school buses. In that case, one of the motivators for us to help keep the sort of recurring subscription costs for the data connection down, I think there is some potential for that to change as IOT deployments and 5G becomes more mature. As IOT deployment increases and 5G becomes more available, those costs are going to drop. I don't know if that is the biggest barrier, sort of looking out a little longer term. Definitely something to think about.

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I have a follow-up here. Rebecca Fisher asked this question in the Q&A. I think this was during your presentation, Hitesh. It might have also been directed at Zach. Can you speak about the ROI simulations

and cost analyses that you conducted? That was a key point you brought up and doing it at the beginning. Are the particular site characteristics? That uses to ensure the financial stability of a project. How do incentives factor into the decision?

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This is Tom. Andrew, I'll try to address a little bit of both of those questions. Just on sort of the component costs and that sort of thing, I would just share with this group that from kind of an order of magnitude, the battery system piece of the project I shared earlier. Order of magnitude, that's about the same as all of those fast charges combined. So, it is a pretty significant kind of project type cost, or upfront cost. That mode of pricing or financing. I wish air, and significant contrast, as Hitesh just mentioned, this type of context, a software side of that, on an annual basis with that 1% of either one of those costs. So, yes, there are absolutely functionalities that can only be unlocked with physical storage on site or backup power of various sorts. But, there is a lot that can be unlocked just to software management. I think it's really important that we don't get -- Lose sight of that and focus too much on physical equipment or physical storage. But, that said, in terms of think about ROI and project economics, I would remind this group of foresight, that enforcer we are still in a market where there are very few business models that are really focused on making money by charging drivers for charging. By and large, we don't seem to have enough utilization of charging stations, and enough adoption of vehicles to make that type of business model clearly financially sustainable. Yes, that is related in some parts to operation and energy costs. But, I do think that it's important to be mindful that we are still kind of growing market days in terms of that type of business model. There are a lot of other types of business models that don't base their economics on charging drivers for charging. I think those tend to present a lot more opportunities to be thoughtful about longer-term benefits and their association with upfront costs and really that ROI consideration. Because, that type of scenario allows for much longer term thinking on ROI. Where is the former type of business model tends to have a 3 to 5 year time limit on it, which I think is challenging too. To recoup physical storage integration costs, unless there are additional revenue streams associated with that.

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I want to move over to another question. Introduce yourself, say where you're from.

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Hi, this is Ben Wender from the Research and Development's vision, California Energy commission. Really appreciate the discussion. A lot of good topics we could take up. I'd like to focus in a little bit on technical requirements. Technical research and development needs to make implementation of these EMS systems a little bit easier in practice, so I'm struck by comparing Zach's presentation and discussion of PowerFlex and their interconnection and interaction with a HD's and would love to hear some thoughts on variability within those interactions. Some key questions they have for you guys. Kind of comparing that to Jordan Smith's discussion of type II systems where the connected load exceeds the rated capacity and kind of have Jordan elaborate a little bit on some of those additional tests that they did in the lab. What types of functionalities would you really want seen beyond UL 916? Maybe the two of you could just kind of dialogue on that together.

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Sure. Happy to say what I know. Our project managers generally deal with determining entity. So, having a UL certification document, as Jordan said, this was, we got started in 2015, we generally did type II. We had to convince people that this was okay having a certification standard. To be able to kind of convince people this is okay. It's incredibly helpful. A lot of times I think it comes down to educating them that they exist. That we are certified by an external entity to be able to do load management. A lot of that comes down to things like we are able to guarantee that we are always within the limits that were set. Also, that we fail over safely. If communication is lost, everything falls back to a safe rate, so in our case, we fall back to that eight amps of charging. Then, we decide the infrastructure accordingly so everyone can fall back to that safe rate and not overload any infrastructure. So, educating the permanent entity that this is okay, that this is according to the code, now, because if you haven't dealt with anyone doing managed charging you might think oh, this is supposed to be always on board. Why are you even trying to convince me that you can do three times what the nameplate capacity is? Jordan, I'd love to hear your take.

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For those folks that no, actually our APO, are a few package list. That is all available to all -- To view that list. So, as part of the process of approving equipment for charge ready, we did work with PowerFlex. In fact, they were the first ones to receive approval from SCE and be placed on the approved package list for a type II energy management system. That was because PowerFlex applied to be a supplier to charge ready. We worked together obviously. PowerFlex and SCE in the SCE labs to develop and demonstrate this evaluation procedure. So, that was successful. This is not really scalable. That's why I always talk about these standards and certification. SCE and all of our engineers, we can't do that with every single system. We are trying to work with the standards organizations to put together a standard that can be -- Result in a certification. Everybody can look at that and say okay, go ahead. Install that and march ahead. We are not quite there yet. I think it was very helpful to work with PowerFlex in the lab to go through. We actually not only performed the test, but to develop the procedure and enhance it. So, a lot is focused on safety. A lot of that testing was focused on doing things that would kind of create errors, and see if that fails in a safe manner. So, there are things you do there was like removing the network. While you have chargers, maybe you have an excess load potential condition. You remove the controls. You just pull the network and you have more cars on there than you normally would be able to support. See what happens. Does that fail in a safe manner? It is those types of things. We look at that. We look at all the network configuration. We look at also the -- There was something there that we worked together on that we had to develop during the process. This was sort of what we call the road vehicle element. Which we found a situation where one of the vehicles didn't perform -- Didn't perform the way it was expected to and supposed to. So, that was a finding on both sides. As a result, PowerFlex made some corrections, and they were able to handle the situation of the road vehicle. It was really a custom development procedure. We think we have the first kind of validation procedure for using EVEMS that was effectively put into practice. Again, we are hoping to kind of get that, those elements integrated into a standard, and we can step back and just let the certification agencies handle that.

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Excellent. Do you want to come on camera, audio now? If you are there?

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Hi. Question related to one of Lydia's claims around neater inaccuracy of the sub meters. I'm pretty certain that during a workshop that I presented at last year, there was contention around the dispute of that conclusion. That meters were inaccurate. I read the connections report and found a number of issues in the procedures and testing the sample size loads. Rest. They were not able to conduct the full suite of testing. That conclusion, if you are referring to that report, since EPIC 1.22 was funded, that's an incorrect statement. I would argue. In addition, the division of measurement standards, they are kind of already promulgated requirements for accuracy. I'm wondering how that report is factoring into your claim, and how the research is coordinated with that? In 2021, all [Indiscernible] at least for commercial sales, public charges, and workplace charges, those will have GMS class one meters.

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So, yeah, I mean what we thought is I think 1.22 pilot is that there were issues with data transfer and data accuracy. We took it into the lab and confirmed the test. We saw confirmed issues. I think PG&E submetering protocols workshops are open to third-party submitting. We just need to be able to meet that accuracy standard. You will see in the submetering protocol that we have developed, we have a 0.5% accuracy standard in there. We are happy to incorporate submetering if we can get third-party meters to meet that standard. We are also exploring what we can do with a utility meter as well. To try to understand from a macro level what that overall cost benefit is to meet that accuracy standard.

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I think [Indiscernible] it is already regulated. Definitely not the same thing.

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Sorry, I couldn't quite hear you. Go ahead, Andrew.

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We have a few minutes left. Just a couple minutes left. We will circulate questions to the presenters for questions we didn't get to today. I do want to have a couple questions. There was an interesting question. Can you come on audio and video if you would like to ask your question? Around local permeating case study. Try to elevate you here. You are still on mute. Sorry. I will ask it for you. So, this question is about what information is helpful when dealing with vehicle permeating.

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Are you there? I'm here, sorry. Sorry about that. Energy management is a real interest for us. We are going to be using that pretty extensively in our upcoming EV ready program. So, a question for Zach really. Once you get into the weeds on this, I would love to hear more about what developing permitting officials have you developed guidelines, guidance with. What has been helpful specifically in dealing with those concerns? As a follow-up, the have case studies that you could share for other permitting officials? Specifically I think like circuit sharing and areas that may have had concern that. I'll stop. Thanks so much.

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Thank you for the question. We do have a number of cases that we have developed. I shot an email over to some of our business development folks that have those links. They haven't gotten back to me yet.

Once I get those I can probably share those with the group. So, those were kind of more on the business side. A little less technical. We also go down into the weeds of some like research transfers that talk about circuit sharing. That is probably going to get more technical then maybe you want. I'm happy to share those with you as well. It has gotten a whole lot easier with some of the certifications. With some updates to the electrical codes that allow this. As Jordan said, working with that stamp of approval opens a lot of doors. We also built up a relationship in the areas that we operate with the local permitting offices. Of educating them of this is okay. We have done these in your area. Or, we've done these in these neighboring areas, and it's all, nothing has blown up. Yes, I think that is kind of a testimonial approach. It is really helpful. I'm going to try to get those to you as they are available.

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Can you share? This goes to everybody that has requested information. Going back to the previous speakers as well. Folks that are willing to share information with their workstream as a whole. Everyone can review and we can send it out to the workstream after the meeting as well.

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Happy to.

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The last question is for Ed Pike.

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Thank you. Thank you, Jordan, for explaining the process for -- That you have used -- One offering on your approved product list. I'm interested in knowing from the IOU's on the line, what responses have you gotten? Are they aware that this is an option that they could use to make their install go faster? Maybe even leverage it for other reasons? Are they aware of this? If so, is it something that they are asking for, or what kind of response have you got?

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We can start off -- So, I checked recently. One point I wanted to make is that the type I and type II energy management systems depend not only on the type of equipment, but they depend on how they are configured. So, you can have a type II energy management system like PowerFlex or others, and they can be installed in such a way that that they are not in fact type II systems. That the infrastructure is still fully sized. So, the last time I checked, we had type II energy management systems installed, but they were not installed in such a way that we are discussing here. In a way that you would avoid upgrading the infrastructure. In other words, it's a full wires installation. It's essentially used as a type I system, where you can still manage the energy for economical purposes. That is still very important and very interesting. So, as far as our charge rating program, that's the only type of installation we have had so far. I should mention that the EPIC projects, and all we do on the technology side is helping to improve our programs like charge ready. That is really how we flow these things out into sort of the mainstream. The mainstream is still kind of a bit tricky and sketchy to get this type of advanced technology through. Through the EPIC projects in the lab demonstrations, and working with the suppliers, on a technical basis, it gives everybody, the utility, everybody confidence to move forward in these types of situations. Has been very helpful to us.

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I'll just add in our infrastructure program, we enable customers to enroll in our pilot. We have had a couple customers enroll in that. We also do specifically for our programs for our infrastructure programs, we do design to load management capacity. We do have a couple of projects where we have proceeded with the project to upgrade infrastructure as it relates to specifically [Indiscernible]

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Excellent. A ton of questions that came in here at the end. I want to post two of them briefly. I'm just going to ask for a show of hands to make this go quickly. I think there are a lot of good questions. [Indiscernible - muffled] to respond afterwards. The two questions relate to whether or not [Indiscernible - muffled] applied to fleet vehicles. There was also a question about whether some of these solutions could be used in a multifamily charging scenario. Not just fast charge, or passenger vehicles. A show of hands, if you feel some of the strategies or discussions apply to fleet vehicles as well. Universal, multi family. These apply to multi family environments as well. We are going to ask for some more detail on that and how those might be the same or different in follow-up comments. I think that is a helpful clarification to make as we go. I want to thank everybody for participating today. Both the panelists, the members of the groups that we have here. As well as the attendees and the questions I came in. We will have a second transportation and electrification workstream meeting on October 27th. You will get more information in the follow-up email that we send out. That meeting will focus on topics related to the role of EV's and BGI as an ability to potentially provide backup generation as part of a multiuser micro grid. Also, there will be some projects and pilots presented related to electric vehicle supply equipment being able to provide great services. So, look forward to the presentations and discussion there. I really want to thank everyone again for the Commons today. If you have additional materials for comments that you would like to send us related to the topic from today, even if you were just in attending, please do. Please send it to the email. Thank you all for participating today. Looking forward to seeing you next time. Thank you very much.