UNITED STATES DEPARTMENT OF ENERGY

ELECTRICITY ADVISORY COMMITTEE MEETING

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P R O C E E D I N G S

(8:20 a.m.)

MS. HOFFMAN: Let's get seated and get the meeting started. And I will do my best to mimic Sue this morning until she arrives -- it gives Paul a couple of extra minutes to get his thoughts together. So we're going to start off this morning with the smart grid Subcommittee activities and plans, and Paul's going to give us an update on that. Thanks Paul.

MR. CENTOLELLA: Okay. Sure, thank you. So, glad to do this, and we're looking here at a continuation of activities. We've had some very good sessions at the last two full EAC meetings that, you know, for those of you who are new to the Subcommittee or new to the Committee as a whole, I would encourage you to go back and look at the March meeting. We had a very interesting session on the evaluation and integration of DER.

We had a range of presentations. We had Michael Caramanis from Boston University talk about the calculation of DLMP. We had Bill

Kallock from Integral Analytics talk about how you forecast and begin to plan for distributed resources on a marginal cost basis.

We had Deepak Divan from Georgia Tech talk about how you can begin to integrate control at the grid edge, managing disturbances at the grid edge, and what that means in terms of integrating DER.

And we had Heather Sanders from our own Committee talk about all of the complexities involved in distribution planning.

In our last full EAC meeting we had another interesting session on transactive energy. We had Lynne Kiesling from Northwestern provide us an overview of what that means. We had Richard Tabors talk about platform markets and how those work. We had Curt Kirkeby from Avista talk about some of their transactive energy programs that they have undertaken with Microgrids and with Washington State University. And from PNNL we had Srinivas Katipamula talk about transactive energy in buildings.

So those were two great panels. We don't have a panel at this session, but we're looking forward to doing something in the March meeting. In the interim what we have done is we have done a series of webinars over the summer looking at a couple of different kinds of things still further investigating this topic of how do you value and how do you integrate DER?

So at our June meeting we had a couple of distribution planners, one former and one currently with Con Ed utility of the future project talking about, in particular, the Brooklyn-Queens project. You see here in that top graphic, a graphic from what is projected to come into play in Brooklyn-Queens to displace the need for a substation there. And what you see is your fair amount of voltage optimization, a fair amount of fuel cell, gas-fired distributed generation, energy efficiency, a little bit of demand response in the evening and a smaller than what one might expect amount of storage. That's actually a fairly modest component of the overall picture.

And you see the black line there which is their need for additional resources in the specific location.

So you can see that in at least a good part of the day they are actually picking up resources under their contract that they wouldn't necessarily need to have at that location, not until they're clear whether that's still cost effective in those particular hours. But overall, some significant savings from this approach.

Then on the July call, the July and August calls were co-done with the grid modernization initiative working group because they were two of the foundational projects for grid modernization that we thought were particularly important in terms of understanding the valuation and integration of DER.

And so the July call we had Jeff Taft from PNNL and some of his colleagues talk about grid architecture, and the fact that the architecture for control of the grid becomes much more complicated as you begin to get into high DER

environments. And so we had a discussion with Jeff on that call about how you might begin to think about an evolution of grid architecture in a way that moves away from a pure engineering control model to something that involves coordination, some of which happens through markets, and may involve some degree of distributed autonomous control, that is acting very fast potentially even on a sub-cycle basis, to handle the kinds of disturbances that happen in the grid when you've got a significant variability from load or resources at the edges of the grid.

And so you see here one of the slides that Jeff used. Actually, it's a slide that was produced by our speaker in the September call, Sascha Von Meier. But it's showing the different time scales at which different kinds of devices begin to apply on the grid. So you see some of the high frequency switching all the way down at the left hand, and these and some of the synchrophasors that we'll talk about later are operating on a sub-cycle basis; whereas, AGC is in

the middle. The kinds of pricing that you see in an LMP market is further out to the right-hand side of that slide.

So architecture has to take into account both the complexity of the system and the complexity of the objects operating under it. But also the different times scales and how you integrate across them. So we had a very interesting discussion about that.

On our August call we had another call with the grid modernization working group. And this one focused on the valuation project, and Stan Hadley from ORNL and other folks on that team were part of that call. And this project is really aimed at trying to create a common set of terminology and some common frameworks for how you might do valuation in a distributed energy environment. And we had some discussion with them about their -- as you can see in the top-left graphic, they are looking at -- well, there might be different things that are valued by different parties. And then different parties might put

different weights on each of those values, whether it's affordability or reliability or resiliency, et cetera.

And so we did have some discussion with them about, you know, are there ways to create a more common framework so that it's not simply a matter of weighting different things that different people might weight differently. And we'll be interested in following where they go with that. I think what we saw is a real effort to try to create some commonality and terminology, some commonality and, you know, at least understanding the elements of a framework.

And then on the September call Sascha Von Meier, who is with University of California, I believe. Is that right Merwin?

MR. BROWN: Yes. She is my replacement.

MR. CENTOLELLA: Okay. So Merwin Brown was speaking and saying that Sascha is his replacement at the University of California. So she gave a presentation on the application of micro-synchrophasors in the distribution system.

And I think the key sort of takeaway from that which you see in the graph on the bottom is the difference in time scale in the kinds of data that you can get from micro-synchrophasors, versus what you might get from conventional SCADA measurements, so that you can actually begin to track, you know, is it something that happened on the distribution network, or is it something that happened in the inverter of a solar installation that may have caused a fault on the system. And so we had a very interesting conversation. Heather was very much involved as a distribution planning person, about what's the real value and applications of this kind of much more detailed data. So these are the kinds of things we've been talking about over the course of the summer.

And our next task is then really to take all of this investigation that people have done and begin to turn it around into thinking about what kinds of topics might we consider for making recommendations to DOE around this topic of valuation and integration of DER. And I guess,

you know, coming off of some discussions I have had over the last couple of weeks, I guess I might even add one to this list that, you know, it may simply be important for DOE to be making the point and educating people that there are differences in the value of distributed resources depending upon when and where they are on the grid because we have a lot of distributed resources that are being added in response to net metering or RPS, or in some states we actually have states, you know, specific mandates for utilities to be purchasing DER without any kind of indication that there might be a difference in value depending upon where those DER end up on the utility system.

But we had earlier in the year put together a list of some of the topics that we might want to explore. And this is not necessarily a list of recommendations or anything like that. That's our next task, is to think about are these the right topics? And if so, what might we say about them back to DOE in terms of influencing the kinds of research and policy

agendas that DOE might undertake in these areas. So some of them represent areas where there is already work underway. Some of them may be areas where we are going to suggest, you know, if the Committee comes to some agreement, new things that, or supplements to things that are underway. So, you know, the list that we had come up with earlier included creating a common understanding of terminology and valuation framework. Something that's being addressed in the, at least in part in the valuation project in grid modernization.

Tools for the evaluation of the time variability and product-specific marginal costs and marginal value of DER -- and we know some of that that's out there from some of the work that's been presented to the full EAC already.

We may want to talk about, are there gaps in those tools and where could they be better? You know, looking at how you begin to analyze additional factors impacting DER valuation. So are there factors, for example, impacting reliability and resilience and how might

they come into value in DER.

You know, some further work on architecture and grid control and really beginning to think about the different types of systems we have in distribution. And how do you think about grid architecture and control in this context? And what more needs to be done beyond the already very interesting work that PNNL and others are doing.

Thinking about how you integrate DER into distribution planning, into forecasting, into operations and how the operations change. Developing an understanding of the structural regulatory barriers and opportunities and understanding stakeholder concerns about moving DER into the market. And finally, thinking about utility rate structures for accommodating high DER environments.

And there may be other topics that we take up, but this was the list that we developed earlier. And certainly if people around the table have other things that you think we ought to be

looking at, please feel free to suggest them when we get to the discussion in just a moment.

So our next step is really to begin to focus on what findings and recommendations we can make out of that investigation. And then, you know, our plan for the remainder of the New Year. We welcome some of the new people on the Committee and hope you'll be joining the Subcommittee. We really would value some of the experience and expertise that you can bring. We'll be looking at the DER valuation and integration question and then kicking off a new set of work looking at the impact of the internet of things on power systems with the hope that by the March meeting we'll be able to put together a panel on that.

So that's where we are. I'll pause and take some questions, and see if there is anything else you'd like us to be looking at. Gordon?

MR. FELLER: So I'm new to the Subcommittee, and I haven't had a chance to look at the past work. This was helpful. Is there a discussion thread around investments that have

been made around smart grid by key actors, utilities and maybe technology or service providers that work with utilities that has a kind of evaluation framework that the Committee has used or other ways of tracking the success or failure of some of those experiments?

MR. CENTOLELLA: So there has been a set of activities that preceded this, you know, that looked at developing analysis of, for example, coming out of the ARRA investments on smart grid. There was a prior set of recommendations to DOE around that. There have been prior recommendations on how to create tools for regulators. I think there have been at least two or three different sets of recommendations that have come out of the Committee in the last three years. And we can certainly get you those. I think they are probably on the website along with DOE's responses to those sets of recommendations.

MR. FELLER: My other question is about business models; the impact of smart grid on the traditional utility business model. We've been

hearing from a lot of utilities that they think they are going to have to reassess how they sell, how they deliver, how they price, and the more fundamental business model behind all of that. I don't know if these issues have come up, and what way they've come up.

MR. CENTOLELLA: Probably not as much as some of the other issues. I mean, that may be a useful topic for us to think about going forward. What I would say is that I think, at least from my perspective, and others may have different perspectives, is in terms of the Committee we're trying to make recommendations to things that DOE can do. So there may be discussions that DOE might be able to facilitate around how to enable utilities to move to new business models, but DOE is not going to be necessarily creating the business models that utilities end up choosing.

MR. LAZAR: I work with a lot of low income and consumer advocates who remain very smart grid skeptical. When I give examples of some very creative things that some utilities have

done with their smart grid assets, they warm up. And I hope one thing that this Committee can do is to help stimulate compilation of examples of creative things that people have done that provide real customer benefit. Burbank Water and Power used their smart grid. The Wi-Fi mesh that does their data collection had so much capacity that they opened it up to free citywide Wi-Fi, eliminating the digital divide in Burbank. That was perceived as a smart grid benefit that was valuable. I think the more of those kinds of examples we can find and the more creative use of smart grid assets that can be identified, the possibility of reducing resistance to deployment, but also the opportunities to give regulators an opportunity to make sure there is a value proposition for consumers is enhanced. And I hope that we can include that in our work in the next year.

MR. CENTOLELLA: Good.

CHAIRWOMAN TIERNEY: Thanks, Jim. Let's go with these two, and then we will go to the next

report. Janice.

MS. LIN: Thanks. I'd like to build on the comments of the last two questions. I understand that DOE can't recommend business models, but it's certainly in a position to identify these innovative practices and/or creative new compensation mechanisms that certain utilities are deploying. And I think we're going to see more and more of that literally in the coming months. And that information via DOE can be described and disseminated because it may be helpful.

MR. CENTOLELLA: Yeah, great point.

CHAIRWOMAN TIERNEY: Laney.

MS. LANEY BROWN: Yeah, and actually I'm continuing to build. I think there are also examples that, you know, to understand the applicability, but around DER evaluation, around model development, around installation and management of things like nonwire alternatives that might prove very useful to others. So I think to help people build those building or

understand and think about those building blocks.

MR. CENTOLELLA: Okay, great.

CHAIRWOMAN TIERNEY: Thanks, Paul.

MR. CENTOLELLA: Sure.

CHAIRWOMAN TIERNEY: And as John is getting ready, I will apologize for being late. I think I am very time zone challenged. My son was married Saturday night here. I flew to London, came back. I'm just totally confused. So after all that discussion last night about starting at 8:00, I thought we were starting at 8:30. So I really apologize everybody.

MR. ADAMS: Good morning, my name is John Adams. This is my first time in front of you, so let me ask you to go easy on me. This is the power delivery Subcommittee report. Going after Paul -- boy, I was really impressed. He went through the entire last year of phone calls. I'm not prepared to do that but I'll --

CHAIRWOMAN TIERNEY: You've got enough with this paper.

MR. ADAMS: At the power delivery

Subcommittee our last calls have been mostly devoted to the Value of a VAr white paper, which we've been working on for some time. I'm actually fairly new to the Committee, so I'm not sure exactly how long this has been going on.

We are talking about new deliverables. And I just want to mention the things we're talking about and look for suggestions. One suggestion which was mine, was to look at the planning process for transmission. We are developing from a single-source -- well, I won't say single -- multiple large source to sync planning model to possible multiple distributed sources. So how to do planning in the future is one of the things we are thinking about as the next deliverable. The impact of high penetration of electric vehicles is something we're thinking about. And Merwin just suggested looking at the interface of the transmission and the distribution system. I wanted to put these ideas into all of your heads. I am looking for additional suggestions at what the power delivery

Subcommittee should be looking at. I wanted to get that out before we started going through the existing work product, the value of our working paper.

The way I'm going to approach this, the paper has a formal set of recommendations at the end. It has a page that's actually labeled formal recommendations to DOE. But through the body of the paper there are several other recommendations that kind of go through in passing. And some of them, I think, are pretty important. So what I've done here is every place in the paper where it said the DOE ought to do something, I've gone ahead and broken those paragraphs out. So I've got five pages of recommendations. This is every recommendation DOE I can find in that 32-page paper. So I hope all of you have read this paper in exhaustive detail, and admired the brilliant writing in it. But just in case you've missed a point or two, I've broken out the salient points right here. I have no intention of reading these slides. I'm going to chatter on about other

things as I flash these slides up.

But I do want to point out what is the Value of VAr and how and where can we best provide it? Although not on the formal recommendations page back at the end, it's in here as a suggestion for DOE.

So I'm going to talk a little bit about why this is important at this time. We are moving slowly from a traditional utility system in which you had a single integrated utility that was responsible for both the transmission network and the generation, and frankly, billing the load and ran this integrated system.

Today at some places, not everywhere, but where I come from in particular, I'm down in Texas, we've broken that model up. We now have transmission entities and generation entities and load serving entities, so you don't have this single controlling entity that is responsible for coordinating all of these simultaneously. So whereas we have this billable element, the megawatt or the watt that everyone knows we are

providing, there is this separate element. And it's really a voltage control element, the VAr or mega-VAr, which is critical to the stable operation of the integrated grid -- the generation, the transmission, the distribution altogether.

Why is it critical? Well, you know, there are phenomena and I'm just going to -- voltage collapse is the most common one, where you can lose stability on the grid and you can lose your ability to transport power entirely through a shortage of reactive power. Now you can also have excesses of reactive power which can lead to high voltage and problems in that area.

But because of this, there becomes a question of -- with the new technologies coming into the grid and with the separation of the entities, you no longer have this single coordinating entity. How are these resources going to be provided to stabilize the grid in the future?

Now there are NERC requirements around

-- we are required to remain stable. So there are places where this is being studied. But in the course of it, the question of, "Okay. What is the obligation of these new resources and how much value should we put into this product that they are providing," is a question.

And I believe that the industry could use the assistance of DOE in trying to help us identify what the value of these imaginary power resources are, as we deal with the fragmented parts of the transmission distribution system. Has everyone had time to read through this slide?

So we proposed that DOE help educate us, help assess the role of the bar in the transmission grid and the ability of different resources to provide these resources, and play a similar role in educating both state and Federal policy makers.

So that gets us down to the formal recommendations page. And this kind of collapses most of the things that were on the formal pages. And here I am going to actually step through them.

But we ought to engage National Laboratories in continuing to research and assess the available technologies for reactive power, including the new types of resources which includes solar. Now should we depend on solar resources to provide VArs? And how should we control them, particularly if they are on the distribution system? Educate regulators and policies about the importance of reactive power. It's a bad thing if the grid collapses. You know, you may have plenty of resources, but if the grid is black, they're not going to be delivering power. So that's a major issue.

Further evaluate the need for equipment manufacturing standards for both photovoltaic systems, variable speed motors, lighting, other electronic devices. The nature of the load is changing. The nature of the resources is changing. And in fact, the way planners plan for the stability of the system -- they take models, and they put them into computer programs. And they study how the grid is expected to respond to

events. Now those models are what we know about how these devices perform. And if we don't know how these devices react to changes in voltage to transient events, then those models will give us wrong answers and a false sense of security that, "Oh no, we built a secure grid. Everything is going to be fine. We know what we're doing." Well, if for new devices we've put in old models, we don't know what we're doing.

So we look to DOE and industry, not DOE alone, but to help us develop these load models that assure us in our planning process and our operations process that we're operating in a secure state.

And finally, they assist policy makers and understanding which reliable services will need to be procured, in ISOs this is always a big question is, okay what services are you buying and how much of them are you buying and how much are you paying for them? It's usually of interest to somebody out there.

So how much service should we be

procuring? What is an optimal or at least a reasonably optimal solution to the question of procurement? So with that, that's the end of my formal presentation. I can accept questions on the paper or on anything else you'd like to bring up about power delivery. And I think Laney had her card up first.

MS. LANEY BROWN: Oh, sorry.

MR. ADAMS: Good, you let me off the hook. Merwin.

MR. BROWN: Thank you. Merwin Brown, UC Berkley. Just a comment on the load model aspect. First of all, I champion you bringing that up because I think it is a major issue with planning the operation of the grid.

But I might suggest that you expand the definition of model to go away from what has historically been a physical model to one that probably uses empirical algorithms, developed from empirical data and even stochastic type models, if you want to call them that because I think that's where we are heading.

MR. ADAMS: I think that's what we intended to have here. Do you think we need to make a change to the paper before we vote on it, or is this sufficient?

MR. BROWN: Not if you feel that that's captured.

MR. ADAMS: I thought it was captured, but I'll look to the entire group.

MR. BROWN: Yeah. One of the reasons is, as I'm told, is the law of the power of electronics that's showing up in the distribution side of things now is making it very difficult to use physical models. And so that's why I think we're going to be headed in a stochastic-type forecasting, if you will, for an operational point of view what loads -- how it's going to behave under certain circumstances.

MR. ADAMS: I'm not sure this is -- could we put a note to that effect in the cover letter accompanying the delivery of this report to DOE, do you think?

MR. BROWN: I leave it to your judgment.

I just want to raise the issue or the suggestion that the load model be considered very broad in its definition; not the traditional, you know, inductance type. The old one was --

MR. ADAMS: Right, right, right.

MR. BROWN: -- basically objective loaders and resistance loads, and it was a physical model. I think those days are disappearing that you will be able to do that.

MS. MARILYN BROWN: Well, I don't know. It might be better to stay somewhat general, allowing for advances both in the traditional, physical modeling and allow empirics also to help inform. I'm not sure. I think both types to be developed in tandem. I don't want the theory to be lost and just result in --

MR. BROWN: No that's fine. If you can come up with the --

MS. MARILYN BROWN: Something very broad and vague might be preferable from my standpoint rather than excluding.

MR. BROWN: It isn't what I'm hearing

from grid operators, but I think you have a good point. And I didn't mean not to look at the physical models. But I just wanted to say, expand the definition.

MS. MARILYN BROWN: Yeah, good.

MR. BROWN: Because I think that it's going to be more and more that way.

MS. MARILYN BROWN: I like that, expansion.

MR. ADAMS: I think Jim was next.

MR. LAZAR: Just a couple of quick points. I was the co-author with Ryan Hledik from Brattle, on one of the Future Electric Utility Regulation (FEUR) papers on distributed energy resources. And one of the things that we said in that paper is that whenever you are inverting DC to AC, typically in a solar system or a battery system, you have the opportunity to create any wave form that the grid desires.

But until there is a value proposition for the solar installer to install a smart inverter and enable that smart inverter to deliver

those services to the grid, it won't happen. We proposed a number of different ways to express that value preposition. My favorite is ten bucks a month for a residential smart inverter.

The other point I want to make is, if any of you don't own a kilowatt, a little device that you plug into the wall and you plug anything into it and it tells you its wattage and it's power factor, you will be astounded when you wander around the room and look at the power factor of the individual appliances in your house. My energy star brand new Whirlpool refrigerator that has more space and makes less noise and uses less energy than any refrigerator before it has a 35 percent power factor because the energy star ratings are based on kilowatt hour consumption with no provision for power quality impacts of the appliances. And maybe we need to be moving ahead with power quality standards within the appliance efficiency standards.

MR. ADAMS: I'm not sure if Paul was next or Carl.

MR. ZICHELLA: Paul was next.

MR. ADAMS: Paul?

MR. CENTOLELLA: So Jim, I'm really amazed at that figure. I had no idea that it was that bad, but I wanted to build on Merwin's comment. And I wonder whether the term load model is too narrow in the sense that it's not just loads, but it's all the things that are happening in the distribution system including resources, including inverters that, you know, may be not only in solar panels, but also in motors and other things. So one of the things that we can see from the data that we're now getting out of AMI, is that our typical model for how voltage goes through a distribution system is not -- it creates the impression of a much smoother pattern than what we actually see in the data.

And so we're seeing situations where utilities are encountering the fact that they may have been at or even been violating standards without realizing it because they never had the data before.

So, broadening that definition to look at all of those things and it's not just a matter of having inverters that are smart. But also if you have a lot of them on the system, they also in some way have to be coordinated with one another, or you just end up with things that are at war with one another and not necessarily getting you to the point where you need to be. So understanding that piece of it as well becomes important.

So I guess my suggestion if you were to make a change, would be to go from simply saying load to saying distribution or saying load and distribution models to make it clear that you want to take a look at more than just the load side of the equation.

MR. ADAMS: Paul, I'm sorry. I need to ask -- I was thinking while you were talking that you were saying, "Hey, you need to improve the models both on the load side and on the resource side," and then at the end I thought I heard you say load and distribution which confused me.

MR. CENTOLELLA: Well, I mean you could just say distribution models. You could say load resource and distribution models. I'm just saying that the term load is perhaps too narrow for ultimately what I think you are saying about models and the distribution system.

MR. ADAMS: I thought I had a thing talking about devices in the body, but I did not find it. So a proposed change would be to say load models, maybe load in other active equipment models?

MR. CENTOLELLA: That's fine. I mean just, you know I just think you want to just be somewhat broader than just saying load.

MR. ADAMS: Does anyone object to that change? I don't object to that proposal.

MR. ZICHELLA: This is Carl. I don't object to the proposal, but I do think your point about loads and resources -- I mean, I think Paul's point was about being more broad and encompassing the various things. I don't want to narrow or expand it just a little bit. This was

going to be my comment anyway. I was going to argue for a broader definition too, for the modeling and load resources, you know, active devices. But if we could figure a way of phrasing this that allows for flexibility for the department to go in any direction necessary, that's really what we need to do. I agree with Merwin that removing increasingly the stochastic modeling in many respects in grid analysis, but I don't even think we need to be that specific because we are going there.

MR. BOSE: I can't let discussion on models go by without commenting. I spent my whole life doing that. You know, one person's load -- when a transmission operator looks at a load, it looks very different when a distribution operator looks at it. And when you are running a building of management system then the load looks completely different. So the models that you use are completely different, depending on the use of it.

So I think broadening it is the right

way to do it, instead of calling it something very specific. Everything that's connected to the grid needs to be modeled, if you are going to have some analytical tools on it, right? So that's a given, but I just wanted to say one thing about what Merwin raised. You know, the models for all these things that are coming out -- electronics, whatever. People develop models as soon as they come out. And they go out in papers and there are -- but the reason you hear complaints that we need more load models is because they are not in the analytical tools yet. And that they won't go into the analytical tools until the people who sell those tools think that it's needed because it takes them time to develop those things, to put it into the code.

And so before we sort of say that we need more research in models, we need to figure out what we want out of it. That is, if the models exist, how do we do it? This discussion by the way comes up all the time in the Grid modernization groups. You know, when you sit on

any of the projects that they are doing, they said well, you know, we need another model. Well, but there is 17 papers already on that model. So what do we do after that?

MR. ADAMS: Sue?

CHAIRWOMAN TIERNEY: I just wanted to step way back and compliment the Subcommittee for this paper. It was definitely a work of love and affection. And both you and David spent a tremendous amount of time continuing to approve the paper. So I really want to thank you for getting it over the finish line in a way that's helpful and accessible. You did a great job.

MR. ADAMS: I'm going to take a moment to actually defend the wording that's there, now that this discussion -- I'm just going to say that in our studies everything really is behind the distribution point, that interconnection point retreat is a load model.

So there is a point there in the planning world, and I'm going to say in the operations world too. Yeah. There is a lot of

active, maybe active devices there, there may be all kinds of things behind there. But at the moment in our mind, that's the load model and in fact EPRI is doing a lot of work on characterizing active devices that are back there and both tools and techniques for us to carry that forward to something that will work in a transient stability study for our planning. So I'm going to defend the word. What I thought when I read this is, yeah, this is the model at that point and that this is sufficient.

So I am going to propose we go ahead and approve the paper as is. And we can include in the cover later, if you'd like, something expanding trying to make clear that that is not just a passive load, but it is a passive and active.

CHAIRWOMAN TIERNEY: Is there a motion to adopt that recommendation?

MR. ADAMS: I move we adopt the paper as is and include the notes of the modeling in the cover letter.

CHAIRWOMAN TIERNEY: Well, and that would certainly heighten the attention to that point. Carl.

MR. ZICHELLA: I'll second the motion.

CHAIRWOMAN TIERNEY: Okay. Is there any further discussion on adoption of the value of VAR paper? Seeing none, everyone in favor say aye.

GROUP: Aye.

CHAIRWOMAN TIERNEY: Approved, that's great.

MR. ADAMS: Thank you. (Applause)

CHAIRWOMAN TIERNEY: Again, thanks very much you guys. I know there were a lot of people who had hands and fingers and typists and everything else into that, but you did a great job.

MR. ADAMS: Great credit to David.

MR. TILL: I would be remiss not to recognize Paul Roberti and Jeff Morris for their contributions, as well as Carl. Thank you all.

CHAIRWOMAN TIERNEY: That's great, thank you. Merwin, I think you are up.

MR. BROWN: Merwin Brown, Chairman of the Energy Storage Subcommittee. And as it happens, I'm substituting for two of my members who were supposed to be here to deliver these talks. And I'll explain in a minute what that means. But I wasn't planning on talking that much.

This morning what we want to address is -- the first thing is an update on the biennial energy storage assessment, and five-year storage plan. And here I am speaking on behalf of Ramteen Sioshansi. I apologize, Ramteen, even if you are not here, for messing that up. Because he led this effort, and he did a terrific job in my opinion.

And the main purpose here today is to get an approval of the EAC to accept the report that's been put together for this.

And the second thing is an update on high penetration energy storage work product that Chris Shelton is leading. And I guess he is not here either. And that one I am fully unprepared

to go in much detail, but I do sit in on the meetings and can bring you up to date on what's going on.

We were supposed to have a face-to-face meeting as a working group after this meeting but Chris isn't here.

CHAIRWOMAN TIERNEY: Maybe he's time zone challenged too.

MR. BROWN: Yes. It could be. So I will give a brief update on that, particularly if we have time because it may take more time to do the approval of the report. So to get into that a reminder -- the motivation for this report, not the only one necessarily, but probably the most prominent one is that they are required by law.

And there are two different kinds of reports that are required by law. This is Federal law. One of them is that every five years we are to come up with a five-year plan. Kind of a look ahead of recommendations to DOE as to what the Energy Storage Program perhaps should be looking at or what it should work on, et cetera.

Then the second deliverable requirement is every two years, they do a backward looking performance review of how supposedly the DOE is doing on the five-year plan. Or I think we interpret that more loosely to mean just in general, how do we feel DOE is doing with respect to the program, satisfying and meeting the needs of, if you will, the nation of stakeholders involved in energy storage.

And this plan proposes to satisfy both of those requirements in one report. And so that's what -- if you approve this report, that's what you will be approving, is meeting both of these requirements. And I'll go into a little more detail in a minute.

It helps to have some history of the evolution of these reports to see why this report looks the way it does, and why it was done the way it was. Number one, back in 2012, we took a similar approach. I happened to be part of that, but I didn't lead it and it was that we combined both the two-year review and the five-year plan

going forward. So in a way, a precedent was set in that particular effort.

And then the 2014 storage plan assessment was just to satisfy the review. And that's been done and accepted in September of 2014. This year's, the 2016 storage plan assessment, is again as I said, is having recommendations that addresses both of these requirements. The scope of this plan -- one is, again, the history helps here to understand this -- the scope of this paper compared to past ones.

The 2012 report focused on storage related activities of the Office of Electricity, primarily. The 2014 report expanded the scope to include OE, EERE, ARPA-E, and the science area of DOE. The report also examined coordination between DOE and other Federal agencies in this, particularly Department of Defense. And this was in line with the offices and agencies included, and DOE's overall strategy that they had at that time.

The 2016 review maintains that same

broad scope from regard to agencies that we looked at. This review also expands to the scope of storage beyond electricity in and electricity out, which has been our traditional focus of the Energy Storage Subcommittee. One, somewhat for convenience then two because that at the time was the interest, if you will, as we understood it.

And we've expanded this one, not wholeheartedly, but a beginning into other types of energy storage such as power to gas, thermal and virtual storage techniques. Sort of now the new rule of thumb, where before it was electricity in, electricity out. It's more how will this energy storage impact the grid operations and behavior, which is a broader definition and in my opinion, a more satisfactory one, although it makes more work for the Energy Storage Committee.

This expanded scope, therefore, covers more potential storage technology. It should be within DOE's portfolio on overall storage related strategy. The background for this report -- the 2016 review was brought in program and technology

scope, which I sort of alluded to already. The review focused on recommendations that were derived from the assessment that can inform -- the recommendations were derived from an assessment that I mentioned, which is one requirement. It's a two-year requirement, every two years. And then also informed the five-year plan at the same time.

And for brevity's sake, we again have sort of changed tradition. In the past these reports tended to be pretty complete stand-alone reports in that they were voluminous and had lots of material on, say for example, what are the different kinds of energy storage technologies that are out there, and sort of what their development is. And we recognize the fact DOE knows that. As a matter of fact, DOE ended up writing a lot of it. And we took their reports to get that information. And so it seemed like it was kind of a waste of time because we could just reference that material, and DOE didn't have to go stumbling through all that to find out what the real meat of the report was.

And so we've omitted that kind of background information in this report. It still ended up being fairly long. Okay, I'm sorry. From here on out, I noticed that the animation doesn't work right.

The process for this report was -- first of all, it was intended to reflect an assessment of this energy committee, the EAC. I'm sorry -- Electricity Advisory Committee. And I'm going to use that phrase, not because necessarily it was this Committee at this stage did this work, but when and if you prove this, then that's the way others will read this. So I use this phrase mostly that the EAC did this because that's the way it will be read by the people who read the report, I think.

But anyway, it's the assessment of the EAC. It's the Energy Storage Subcommittee and in particular the members of the 2016 review working group that Ramteen led.

The review was partially informed, and I might add, largely informed by 16 interviews

conducted by the working group with representatives of users, implementers, researchers involved in the energy storage industry. And there is a list in the report, and I also have a slide that shows them. But I don't think we'll take time to look at all of them, unless you require that.

The interviewees offered wide ranging views on some topics, while other views were shared nearly unanimously. And those, of course, impacted our recommendations. They were universally or unanimously suggested by the stakeholders. And they probably got a strong recommendation or a strong endorsement in our report.

However, note that ultimately the 2016 review reflects the views of the EAC. I mean, at this moment it reflects the views of the Energy Storage Subcommittee. But if you approve it, please remember that. And not necessarily those of the interviewees.

This is the list of the people who were

interviewed. I'm going to go on, but it's there. And it's also in the report. The report timing -- I mentioned that we did combine the two. This is a lot of words, but really the bottom line is this, the 2000 and, I'm sorry -- the two- year review was due this year, this calendar year. And so it was really due for this meeting because this is the last chance to get your approval of it. If you don't approve this, then we'll probably be in violation of the law.

CHAIRWOMAN TIERNEY: And what is the law going to do to us if we don't?

MR. BROWN: I'm not sure I want to challenge that. Actually, the truth is I'm not too worried, but nonetheless that doesn't mean I don't want you to think real hard about accepting this, no undue pressure here. The five-year requirement though, the five-year plan actually comes due in 2017. But there were two reasons we decided to combine them. One of them is that -- well, there's actually three reasons, but there's two stated here.

The unstated reason is the work to do the review was also very useful for doing the five-year plan. So that was economy. But you didn't have to do the five-year plan just because of that economy. You could have gathered the same information and then write the five-year plan next year.

So the real reasons that make some sense, I think, here is that one, because things are changing so fast in this environment that we felt that -- these things have short shelf lives, unfortunately. And so we felt that if we had a very long time from when we conducted the interviews to when we put out the five-year plan, it would be stale, and could be even wrong by that time, which says something a little bit about the value of our recommendations I suppose. Beware, they could go out of date rather fast.

The second reason was, we're pretty sure that there will be some kind of new leadership coming into the Department Of Energy in 2017. So we wanted the DOE to have the benefit, if they see

it as a benefit, of the material in this report and including the five-year plan. So that was another reason for moving the due date up on our own volition. Does that make sense?

The report format goes this way. It contains 15 recommendation areas which are organized into the following three broad thematic categories -- general assessment and recommendations, technology developments, and economics and markets. Each recommendation area is discussed in greater detail in the 2016 review and includes -- by the way, this refers to the -- in contrast to the executive summary, that statement -- includes the following. There are comments. A summary of the feedback and comments that were received from the interviewees or the EAC members and provide the framing contacts for their recommendations. I highly recommend reading them if you haven't read them. They are rich with information and material and frankly, are very critical to supporting the recommendations. And then the recommendations are specific

recommendations for the Department that are derived from these comments and the feedback received.

So what I'm going to present to you came out of the executive summary which tries to summarize the 15 recommendations into 10 sort of broader consolidation of these recommendations. And before I get into this, I might just give you a preview of what you are going to see if you didn't notice it when you read it. Most of these recommendations really center around the fact the DOE is doing a pretty good job on the technology side. What we learned from the stakeholders is they're really not aware of it. They're not getting it. And so most of this stuff I would say falls in the area of tech transfer. It's worded differently in a lot of different ways. But that's where a lot of this material or a lot of these recommendations come from, not all of them as you will see.

The other thing I might mention is, having a long history of working with DOE, some of

these recommendations, I suspect, DOE cannot totally fulfill just because of their charter or because of lack of resources. When this was happening I resisted stepping in and doing some editing that says, no, let's don't do that because DOE -- I don't think that's in their purview. Because I got to thinking I really shouldn't be expressing those opinions. Let DOE decide whether or not it's in their purview. And so I feel there are some recommendations, and they would probably fall in that category. So I just want to set that stage that this is looking at DOE in a very, very broad way and perhaps goes beyond DOE's scope to some degree.

The first set of recommendations have to do with improving the visibility and publicity departments of high quality energy storage related R&D. And I don't know how much I need to go into detail on these and explain it to you because to do so is going to take quite a bit of time. And I guess I'll just, for the moment I'll go through these high-level descriptions. And then if we

need, we can go back and talk about more explicitly what's in some of these because again, I highly recommend reading the whole report because there is a lot of material behind each one of these and what they mean.

And some of these sound very similar unless you read the report and see the distinctions. So this first one has improved the visibility and publicity of the Department's high quality energy storage research. And this is basically, again, a lot of stakeholders weren't aware of what DOE was doing. Make the RD&D publicly available through industry conferences and open access journal publications. What's behind this is a lot of the stakeholders, and particularly regulatory bodies, don't have the resources to go into peer review journals. They are pretty expensive. And they may not come to DOE workshops and things like this. They may be limited to industry conferences. So the point is DOE, we felt needed to reach out more than they have traditionally. We think at least more

traditionally.

And then the third one here is address the needs for energy storage operation and planning models. This is a breakaway from the tech transfer kind of aspect. Other than the visibility issue, which came out number one as far as the recommendations and issues that came from the stakeholder interviews, this one came out probably number two, which was they believed there was a deficit of models that really would apply to energy storage operation and planning. And again, the report goes into quite a bit of detail what that means. But I want to highlight it here as another significant area to look at among all of these.

And then the fourth one was commission studies to understand market design and regulatory impediments to capturing energy storage value. Frankly, that's a discussion that's been going on in this meeting, on a lot of subjects and on prior meetings. So it's not new, and it's not surprising that this is something that

stakeholders would very much like DOE to help them with. And again, I understand there is obviously some limits on what DOE can do in this area. But there is also some things that we think they can do.

This is again in a similar vein of tech transfer. Educate state regulators and utilities on energy storage technology. This goes back to the same comment -- is that there are relatively few state regulators and even there are quite a few utilities who don't have the technological wherewithal, the staff, if you will, to go out and get this stuff. And yet they need it. They need the information. So DOE may, as recommended here, do more to, if you will, push the information out to them. And you will see in the report there were a number of instances where we suggested that DOE, if they can find the resources, put resources, to make them available specifically for that point of view. In projects in a contract, part of the contract performer's job will be writing these papers for the open journals, making

sure that they attend conferences and present the findings of these reports, et cetera. And even finding resources to perhaps make available government entities such as National Lab Experts, who could meet with these people. All require more resources.

But I think what we are trying to point out is if you can get those resources, we think they'd be well spent to expand on what DOE already does in this area.

This one is broaden and add energy storage related goals to the Department's existing list. Again, this one you need to read the report. But what was pointed out was because of the historical development of the energy storage work, the current statement of goals tends to be fairly specific like for energy, for renewable integration or for et cetera. And it was suggested that in order to -- if you will not bias either the research or the use or the type of people who would want to use that research, make the goals broader and therefore make sure that

energy storage can address more service needs than might happen with the statement of the goals. I don't know how much -- whether it should be emphasized a lot because it's a bit of semantics. But it's also, I think, a bit of kind of mindset. If the goals are broad in general, then perhaps the technology development would have a more fungible application in many ways. And again, this is just something that the stakeholders have noticed and are pointing out.

The next one is providing additional funding resources for energy storage, RD&D. This is the more traditional role, and it's the one DOE has been very good at, one of the best, but one, it felt more is needed. And maybe not fairly in total, but nonetheless, for a comparison the energy storage budget was compared to the solar budget. And many stakeholders felt that energy storage should be on par. I don't know personally if it needs to be one for one dollars because, I mean, it's not that much but nonetheless, the point was there perhaps needs to be a national

focus on energy storage and increased emphasis related to something like the energy storage emphasis.

Also, because I mentioned up front that we've expanded the scope into energy storage devices beyond the electricity in, electricity out. That's another area. I think DOE already is working in some of these areas. But again, the recommendation is to increase or strengthen the focus in those kind of energy storage technologies as well.

Oh, I forgot to mention something. I think it fits in number six. Another one that actually personally surprised me a bit, but on reflection it makes some sense, some of the stakeholders were a little bothered by the emphasis on research on lithium type battery systems. They felt that, I believe -- I hope I'm not putting words in their mouth, that that technology is really more in the hands now of commercial development. And it's being developed and so that the focus should shift to some other

kinds of technologies.

Again, read the full report to get the full impact of that statement. But that was another thing that was mentioned on this program.

This one is a perception again from stakeholders, as it encouraged better coordination of energy storage RR&D between OE and EERE. And it was felt there was some duplication going on, and not necessarily coordination with different offices and areas within these two offices of DOE, that would be more efficient and better, if there was coordination -- better coordination, I should say. I think I have to let DOE decide whether that perception is accurate or not. But it is the perception, and that is a fact.

Make energy storage safety experts available as a source of informed and unbiased information. This is one that a few of the stakeholders brought up because they feel that -- and this also goes back to DOE's involvement in the visibility and getting the information out, is that many of the stakeholders feel that the safety

of energy storage is not balanced in its representation in the public media.

And they felt that with someone like DOE having the ability to get storage safety experts available in more forms and in more ways, would give a more balanced picture of what the safety situation is with energy storage.

And this is the last one. And this one is to provide short term seed funding, which really, if you read the details, it's really some kind of loan mechanism to help energy storage and development deployment. Obviously, it's very similar to contract R&D and grants, but in this case DOE will get their money back in a loan situation. But this is another one the stakeholders brought up.

So I'm almost ready to call for a vote for questions and discussions and then vote. But I want to point out two things in this report that I think we need to have Ramteen and/or the working group clarify because in rereading this just before this meeting, there were two things that --

and I did read it before then. By the way, I have read the drafts and marked them and commented on them. But one thing that bothers me on page seven of the report is under recommendations. Under the recommendation 4.3, I think some strikeouts got struck out. They aren't there, that were in that description. It was related to making the goal statements more general and more broad, so that the research would perhaps have more general applicability. I think something got dropped here. I'm going to suggest that I take it back to Ramteen. But for the purposes of your voting on it now, I think it's fair to say that regardless of how this changes from Ramteen it won't change the actual recommendation. So I don't think it should change your vote, but that's for you to decide. But I just want to point that out to you. I'd like Ramteen to look at that. If you vote this in, it would be a change after you vote it in. And I hope you have the faith and the confidence that you can accept that change.

There is one other one that I think is a

mistake that I want Ramteen to look at. And again, I don't think it has enough substance to change the essence of the report and that is on Page 11 at the very top. In that first paragraph there is a parenthetical statement that says without DES. I'm thinking that was a comment from someone that got left in. It doesn't make sense. I think it really means that historically this type of work did not include DES. That's really the bottom line. But you could even strike that out, and I don't think it changes the statement. But I just want to make sure with Ramteen.

So with those proposed modifications and your trust that we'll do the right thing on that, I'm open for discussion and comment.

CHAIRWOMAN TIERNEY: Let's do a motion to approve and then comments.

MR. LAZAR: I'm going to make a motion.

CHAIRWOMAN TIERNEY: Perfect.

MR. LAZAR: I'm going to move that we approve this report as corrected by Merwin for the purposes of satisfying the obligation in 641(e)

(5), which is a two-year obligation. But remand it to the Committee for further consideration of discussion of ice and chilled water storage for air conditioning and water heating and water pumping as storage technologies and bring it back to the Committee for approval to meet the 641(e) (4) deadline of 2017.

CHAIRWOMAN TIERNEY: Is there a second?

MS. MARILYN BROWN: Second.

CHAIRWOMAN TIERNEY: Thank you, Marilyn. Okay, comments. In fact, Jim, do you want to comment further?

MR. LAZAR: I'll just speak briefly on the motion. On page 13 of the report there is mention of water heating and water pumping. But there is no mention within the paper on ice or chilled water storage. The thermal storage technologies tend to have round trip efficiencies in the 95 to 115 percent range, as opposed to the

electricity storage options that have efficiencies in the 65 to 90 percent range.

And I think that in giving a five-year report of guiding the Department in the next five years, we need to be looking at both electricity and thermal storage and get some water pumping, kinetic storage options. And those are missing from the report. I made this motion after consultation with Rich Cowart, who sat here through the last half dozen years of discussion of this and the last couple of these reports. And I'd like -- by the 2017 deadline I think the Committee can clearly augment this document. I don't anticipate it being very different a year from now on. It's approved to meet the five-year obligation.

CHAIRWOMAN TIERNEY: Does anybody have any comment in addition to anything Anjan might say? If somebody would advise the Committee about the workload implications of that, I'd be interested in hearing.

MR. BOSE: I agree with the sentiment,

but I think it's not a good idea to complicate our okay approving this report. I think we should approve this report as is and not put a condition on it that something will be added to it next year. Even though we have, we always have the right to add things to a report next year. But I don't know if we need to condition the approval on that and complicate the issue.

CHAIRWOMAN TIERNEY: Thank you, other comments? Janice.

MS. LIN: I have another minor comment that's unrelated to this issue.

CHAIRWOMAN TIERNEY: Yeah. We are talking about everything right now.

MR. BROWN: Excuse me. Can I address this though --

CHAIRWOMAN TIERNEY: Sure.

MR. BROWN: -- specific because maybe we can put it to rest. Why couldn't we just put those particular storage technologies in the text and that's it?

MR. LAZAR: That would certainly meet

what I need.

CHAIRWOMAN TIERNEY: Okay that's great. Paul and then Anjan.

MR. CENTOLELLA: So I did note, and I don't know whether this covers your concern or not, and I'm on, what page am I on? Page 9 there is a reference and the sentence reads, "In terms of technologies thermal power to gas and virtual energy storage i.e., demand response were noted as needing more emphasis." Now I don't know whether that phrase of thermal storage fully covers your concern or not, but I didn't want it to go past everyone that there was at least some passing reference to the technologies that you are talking about.

MR. BROWN: I know it was meant be in there. The technologies you mentioned were discussed, I'm pretty sure. I remember them being discussed, particularly ice storage. So again, my recommendation is, if you'd even be willing to just write those words in at the right place, then we can have the report amended accordingly.

MR. LAZAR: So the words would be, consider ice and chilled water for air conditioning as a storage technology and water heating and water pumping controls as storage technologies. And where it goes as a document matters not to me.

CHAIRWOMAN TIERNEY: So would you agree to amend your motion so that it says that you would like to approve it with the additional language?

MR. LAZAR: Yes. I move to amend my motion to approve the report with the addition of the language I just read.

CHAIRWOMAN TIERNEY: Thanks for that, great.

MR. BROWN: Thank you, and would ICF please capture that for me since he stated it rather explicitly?

CHAIRWOMAN TIERNEY: Come on Merwin. Okay Janice, you are on.

MS. LIN: Thanks, this is a case of when you look at the same document a lot of times and

then you wait and look at it again. And you are like, oh, that's a little confusing. So my one suggestion, Merwin, in the summary where under the section of educate energy storage -- educate state regulators and utilities on energy storage technology -- it's item five on page three.

MR. BROWN: I'm sorry. I couldn't hear you. The sound system isn't working right.

MS. LIN: Sorry, I'm making one tiny suggestion in the spirit of making what we have written and the work that's done here.

CHAIRWOMAN TIERNEY: Can you hear because there is a hum.

MR. BROWN: No I'm --

MS. LIN: It's just mine. I don't know why.

MR. BROWN: Yeah. And maybe, I don't know whether it would help to get closer to the mike, but there definitely is a --

CHAIRWOMAN TIERNEY: It's the mic, but don't take it personally. Okay, especially because this is your topic.

MR. BROWN: Okay, yeah. So please start over.

MS. LIN: Sorry, Merwin. Okay. So this in the spirit of just for greater clarity, it doesn't change the content at all. But I noticed in the summary on page three where it says, "Educate state regulators and utilities on energy storage technology." I would like to respectfully add that we insert and uses right there in the heading and uses at the end of the paragraph. If you look in the detail, it talks about educating them on how you would use it, which is I think going to be much more impactful than just telling them about technology.

MR. BROWN: Okay. So you are in the summation of the recommendations?

MS. LIN: Mm-hmm.

MR. BROWN: Okay. I'm sorry. I'm slow. So which recommendation was it?

MS. LIN: Number five.

MR. BROWN: Number five, okay.

MS. LIN: And just right after energy

storage technology, insert two words, "and uses" because it's not just about the technology. It's how you use it. It's the valuation, which is all in the document, right? But just to be clear.

MR. BROWN: And I'm very comfortable because that would fit with the working group. Yes, but --

MS. LIN: And add it in one more place at the end of that paragraph about energy storage technology and uses at the end of the sentence. Thanks.

MR. BROWN: On the next page?

CHAIRWOMAN TIERNEY: John.

MR. ADAMS: I have no criticism. Isn't that unusual? But I did want to point out something that wasn't in Merwin's summary slide. That's recommendation 13 in the report -- commission studies to fundamentally revisit electricity markets from the bottom up, many of the principles underlying today's electricity market designs were developed 30 or more years ago when power systems were dominated by large

centralized dispatchable generation. If it was on the summary, I missed it. And I think that's a big deal. I do support it, but I wanted to point it out before we voted on it, thank you.

MR. BROWN: Okay. Again, I'm sorry. Where were you finding this information that you want to move to the summary?

MR. ADAMS: No. I'm not asking you to move anything. It's already there. It's in the recommendation, recommendation 13.1.

MR. BROWN: Okay.

MR. ADAMS: It just wasn't in your slide.

MR. BROWN: Oh, in the presentation.

MR. ADAMS: I know you had to, you know, select because there is a lot in this report.

MR. BROWN: Okay.

MR. ADAMS: But I'm market-centered. I wanted to point that out before we voted on the document. Thank you.

CHAIRWOMAN TIERNEY: That's great.

MR. BROWN: Okay. Thank you.

CHAIRWOMAN TIERNEY: Are there any other comments?

MR. ZICHELLA: Yeah. This is not a suggestion for any changes. I just wanted to just recognize how much work went into this and the outstanding leadership. He is not here, but Ramteen's work on this was really great. I had the pleasure of participating in some of the interviews. And I just thought the entire effort, which took quite a while and the active involvement of many people, not just in the interviews but in the drafting. Just, it's a really great job, and you know, I think we should all be very pleased.

(Applause)

MR. BROWN: I second that. As a matter of fact, Ramteen pleasantly surprised me by meeting this date. I didn't think he'd make it because historically, we've not been able to meet that kind of tight schedule with these things. They usually go on and on, and he kept us on track. He did it. He was clear, and he's

focused. I was impressed, really impressed. And when I saw what I thought was good quality material and a lot of it, that impressed me even further because it's -- you can meet a deadline if you put little in it. But he managed to get a lot, he and the working groups, so yes.

CHAIRWOMAN TIERNEY: Well, clearly he was afraid of the law.

MR. BROWN: Yeah, that could well be. Knowing Ramteen, I doubt it, but anyway --

CHAIRWOMAN TIERNEY: Exactly. So could we just hear an enthusiastic endorsement of this report as amended? Yes, good. Thank you so much. That's great.

MR. BROWN: Okay, thank you.

(Applause) Okay. Update on the high penetration energy storage work product that Chris Shelton is leading -- this is my characterization of this product, which is what if the dog catches the bus, what does it mean? In

other words, if we get high penetration of energy storage, what does that mean for the grid, good and bad. And so the point being that we felt this kind of study may help DOE get some perspective on what maybe they should be doing or thinking about doing to get ahead of the curve, if you will, if energy storage comes in very high penetrations. And so one of the things for the new members in particular -- well anyway, here is the bottom line. The grid needs better understanding of the potential benefits versus the dislocations of high penetration energy storage. That's Chris Shelton who is really the leader behind this. He was the one that recommended this project to our Subcommittee. This is in a similar

vein to what NREL has done with looking at high penetration renewables and what impact it might have on the electric grid. This is a similar thing. What we're trying to do, is to characterize the problem statement for DOE, not answer it. That's what we are asking DOE to do if there are any things that need to be answered, and there probably are. So the purpose of the white paper would be implications of high penetration of energy storage into electricity transmission distribution systems, is to examine qualitatively the implications of high penetration of energy storage in electricity transmission distribution, provide a framework for identifying quantitative measures to more thoroughly characterize the vision

of energy storage as an agent in the grid, while physically and institutionally and defining the grid technology and R&D program that would enhance the benefits and mitigate the dislocations of high penetration energy storage.

I'm going to stop there with slides. But just to fill you in -- particularly again, for those who are new here. But I won't go into a lot of detail like I have in the past on this. We decided to take a scenario planning approach because the future is so unpredictable because all the tensions that are trying to be resolved right now. And we don't know which way they are going to go in this industry, made it very difficult to be very deterministic about this. And so we felt that scenario planning was the best approach. And so Chris Shelton took that on wholeheartedly. And now he is at the point where the working group has come up with four scenarios and described them. And they have been written, and now he has begun

to put together the report. There is an outline with some information material already in it as a draft. We were to have a meeting after this meeting today. I guess we are not because it was going to be at Chris' place. And I don't know if we all showed up over there without him, they would let us in.

So nonetheless, we are making progress. We are on the way. The last time I talked to Chris, he was planning on having this done in time for a March meeting review. Again, the pressure, since there is no legislative requirements to do this particular product, we put pressure on ourselves to make this go faster. Again, for the reason of new administration coming in, and we'd like to have this information available to DOE if it would help them on that circumstance. So we are shooting to have a March EAC review of the white paper and vote on it at that time. I don't know whether we will make it or not. Obviously, I got to get with Chris again. I just didn't -- I thought he would be here. And of course, we talk

about this regularly in our meetings, at least monthly. So that's the update, I think, and I'm done.

CHAIRWOMAN TIERNEY: Does anybody have any questions that he can answer?

MS. HOFFMAN: I just was running across in a news article about Germany and what is it -- Sonnen, S-O-N-N-E-N, looking at basically, you know, solar and storage and offering free electricity for customers and trying to really develop a business model. And so I just think you might want to take a look at -- of course, some of the things that are happening in Europe and other places as a leading edge kind of discussions and challenges. You know, Hawaii was the leading edge on the integration of renewables, but let's look at some of the other places that are leading edge in this area.

MR. BROWN: Okay, and this is Germany? Yes. Thank you.

CHAIRWOMAN TIERNEY: Great, any other comments? Thanks so much, Merwin. This is going

to be a very, very informative paper. With that, we're going to take a quick break just until 10:00. And I would remind you that if there's anyone in the room who is interested in making public comments at the end -- I'm not talking about the Committee members in suggesting that, then please sign up outside on the sign-up list for comments.

And then secondly, if you would like a copy of the final work products of the Committee, and you are not a Committee member, there is also a sign-up sheet, just to put your name in there. So we'll see you back at 10:00. And we have a great panel coming up. So I'll try to be on time.

(Recess)

CHAIRWOMAN TIERNEY: -- do some moderation roles for this panel.

MR. ALMGREN: Yes, please.

CHAIRWOMAN TIERNEY: Thanks everybody.

MR. ALMGREN: We got it ready? Let's start. As an introduction, this year there will be about 17 million passenger cars and light

trucks being sold, so about 17 million vehicles will be sold in the United States. About 125,000 of them will be plug-in electric vehicles. Accumulated by the end of the year, there should be more than half a million of those plug-in electric vehicles in the country. That may not sound as much, but I think assuming that the growth will continue and maybe even accelerate with the Tesla Model 3 and the GM Bolt coming on stream, I think it raises the question for, which we have discussed as a panel, how that will impact the electric grid. And I think you can see your glass half empty and half full. You can see the same thing with the plug-in electric vehicles from a grid perspective. And very hypothetically and just for the case of illustration, the one million cars could be seen as

gigawatt hour any storage source, and that's big. Or it could also be seen, very

hypothetically, and again, just as a case of illustration, if you would charge one million cars with a 40 kilowatt hour battery, and

you start it from zero and you want it to do that at the same time in two hours, you'll need about 20 gigawatts of power during two hours, like 20 nuclear power stations. So with these illustrations, yes, when we start getting to some high numbers, it will have an impact. And it can be an opportunity. It can be a challenge. So to discuss this topic and related issues, we have gathered a very distinguished panel who will carry this perspectives and also bring the consumer perspective, the grid operator perspective, and the load serving entity perspective. So I will introduce the panelists. I'll introduce all of them now, and then they will speak in the sequence they are sitting. And after that, depending on the time, we will have Q & As.

So first is Chris Nelder, and Chris is electricity manager at the Rocky Mountain Institute. He hosts the new transition show podcast. He has written two books, over 200 articles on energy matters published in a number of magazines and journals like the Economist and

Telenews Unit, The Financial Times, Greentech Media. And also very important that earlier this year, RMI presented a report where Chris was one of the co-authors about electric vehicles as distributed energy resources, a report I highly recommend to read. The next speak will be Mateo Jaramillo. He's the vice president of products and programs for Tesla Stationary Energy Storage Program. He is also currently responsible for Tesla's energy product line and business model definition, as well as global policy and business development. Prior to Tesla he was the chief operating officer and part of the founding team of Gaia Power Technologies, an earlier distributed energy storage firm.

The next one is Tom Doughty. He is the ISO, California ISO's vice president of customer and state affairs, and he joined ISO, California ISO in 2003, and before that had an executive position at Los Angeles Water and Power, and also a subsidiary of Xcel Energy. And he is responsible for the ISO's interactions with

California regulatory and governmental bodies. And also very interesting, in the late eighties, he was among a small group of innovators that drove the launch of electric vehicles in the U.S.

Watson Collins of Eversource Energy -- he will represent load serving entity or more precisely, Eversource. He is the manager of business development at Eversource. Among other responsibilities, he worked with the stakeholders across Connecticut, Massachusetts, New Hampshire on infrastructure and policy approaches to support plug-in electric vehicles. In 2009, Watson spearheaded a formation of Regional Electric Vehicle Initiative, and in 2015 he was appointed by the Governor of Massachusetts, Zero Emissions Vehicle Commissions advisor for numerous other state and locally planning and initiatives. So with that, Chris, please.

MR. NELDER: Okay. Well, this is probably the most savvy audience I've ever spoken to. So thanks a lot for having me here. And I'll try not to insult your knowledge and intelligence.

This paper, which I spent the first quarter of this year working on, was really designed to explore the opportunities that dynamic charging can offer to the grid in terms of services. We explicitly ruled out talking about V to G because it essentially doesn't exist yet. There is a lot of things that have to be changed in order for V to G to really work, not least manufacturers allowing vehicles to be used that way without invalidating the car's warranty. So we just restricted ourselves to talking about how dynamic charging can offer grid services. And this was a production of RMI's E-lab, so it was a collaboration. Jim Lazar contributed some material to the report on behalf of RAP, and we also had quite a bit of input from San Diego Gas and Electric from some of the pilots that they have done.

So what we are really trying to highlight here is that electric vehicles are a dynamic grid resource. And if we do electric vehicle charging control in an intelligent and

proactive way, we think that that can actually optimize all of the grid's assets and help to extend their useful life largely through reducing thermal wear. It will help to avoid new investment in grid infrastructure because we won't have to add peaking capacity. It will help supply ancillary services like frequency regulation and power factor correction. It can help absorb excess wind and solar generation. So it would essentially curtail curtailment. It can help reduce emissions because, of course, you'll have more renewable energy on the grid, and you will be using less petroleum. It will help reduce electricity and transportation costs. Transportation costs because it is simply cheaper to refuel an electric vehicle with electricity than it is with petroleum. And reducing electricity because we think that through this optimization function, it will actually reduce the per unit cost of electricity on the grid.

And so we're really going to look at -- the main mechanism by which all this is going to

work is load shaping. So we want to use the EV charging to fill in the valleys and avoid the peaks. And there is two major approaches to that, the carrot and stick. The carrot would be advanced tariff design, and here we are really focusing on time of use rates and other kinds of dynamic real time pricing to create incentives to charge when the grid power costs are low and add incentive to charge when costs are high. And then on the stick side we actually think it's possible with appropriate telemetry and other kinds of infrastructure support, for utilities to directly control charging stations, either through a one-to-one connection or via aggregators. So the way that we've tried to express this, is we've looked at five different states in the report. And we looked at kind of your basic load shape in those states. And then we've looked at an idealized load shape in each of those cases where we manually moved around the shifting of vehicles, in order to have the optimal outcome on the load shape for that state.

And so here is an example of the HECO grid, the Hawaiian Electrical Company. At 23 percent electric vehicle penetration with uncontrolled charging -- that's the top chart there. You can see that when people come home around 5:00, it actually increases the peak, the neck of a duck. And if we do an idealized charging shape on the bottom chart there, we are actually flattening the curve substantially. That's what we are trying to do here.

The advance utility services that we're really trying to identify here as opportunities, basically falls into three categories -- demand response, power quality and mobility as a service. On the demand response side, we think that, you know, basically by turning off chargers at times of peak load and combining stationary storage with electric vehicles, like the pilot that BMW is doing right now with PG&E, we can avoid capacity investment at the peaks and help customers avoid demand charges. On the latter point, you know, it's really going to be more of a question of

whether residential customers are becoming more exposed to demand charges. But for now, that would be probably more of a corporate application.

On the power quality side we see groups of vehicles being able to bid into ancillary services markets. And this is something that's already being done in California. Maybe you'll comment on that later, but essentially we are looking at frequency control, voltage control, transition generation, power factor correction and ramp rate reduction. That's kind of the main ancillary services that electric vehicle charging can provide. And sort of in a somewhat separate way, RMI has a mobility group that's working on autonomous vehicles and mobility as a service. They've got some pilot projects going in places like Austin and they have -- their input was, look, we really need to think about EVs charging at a charging hub. And here we're imagining, for example, a brown field probably close to a substation with the help of a utility to identify where that optimal location for a charging hub is.

Where you could bring in fleets of electric vehicles. Maybe autonomous, maybe not, but you can support services like Uber and Lyft with this kind of an approach.

And by doing that and being able to charge these vehicles at such a hub, you'd be able to provide probably the lowest cost way of getting those vehicles charged, and the maximum control over large groups of vehicles, so that you could actually provide a very significant demand response service or ancillary service to the grid. So in this case we are imagining fleets of vehicles that are actually rented and not owned, probably rented by, for example, Uber drivers. This would be a high density, high- use application. So the vehicles would probably be in operation 18 hours a day or more. And companies that are testing this approach include Tesla, Entergy, Greenlots and ChargePoint.

So obviously, one of the big objectives to vehicle electrification is just being able to reduce emissions. So we think that electric

vehicles based on the available research including a report, a recent report from NREL, and I involved the author of that report quite closely in developing my report, found that electric vehicles on the grid can reduce net emissions even on coal fired power grids compared to conventional vehicles.

And you know, the main reason for that is simply the low efficiency of a nice vehicle. Net and EV emissions from the power grid and fossil fuel combustion in a conventional vehicle obviously varies by generation mix as the mix changes over time, and the time of day the vehicles recharge, all those things will affect your outcome. But the bottom line is that electric vehicles are pretty much always and everywhere a net reducer of emissions. And the best policy for reducing emissions is to increase renewable energy on the grid while deploying the EVs and then gradually reduce the carbon component of your grid. And here workplace charging stations and charging stations located at shopping

malls and things like that are going to be an important element.

The other major benefit that we see to vehicle electrification is just being able to absorb more wind and solar on the grid. It allows you to get that share higher. There is two mechanisms for that. The first is just reducing curtailment, as I suggested. But the other mechanism is that you are actually using the vehicles as big sponge to soak up more and more wind and solar than would be otherwise possible. And that's where you get into grid balancing issues and things like that.

So we are going to use them to end curtailment, enable more renewable development and make variable renewables dispatchable essentially by absorbing wind and solar when it's producing and then calling on the EV storage instead of calling on grid generators. And this is where, you know, obviously, we are trying to open a door here to V to G to show the rest of the stakeholder community around EVs to make that possible.

So California has the most EVs on the road of any state, about 200,000, the most ambitious EV deployment target having 1.5 million zero emission vehicles on the road by 2025, and the most experience in EV pilots and advanced tariff designs. So at the end of this report we really did a focus on California to try to highlight some of the lessons that those utilities had learned and there was a couple of different points to that. I won't expand on it too long here, but the EV project highlighted what SDG&E has found with its experimental tariff design. Some pretty interesting findings there, including the fact that time of use rates were found to be very effective at shifting, charging to off-peak hours and that without the time of use rates, drivers would just plug in when they got home and it would exacerbate the duck curve.

With the time of use rates, they were able to shift charging to basically the nighttime hours. SDG&E also bid aggregated EV fleet vehicles as demand response assets into CAISO as

both energy and ancillary services, and did so successfully and are looking to expand that now.

As I mentioned earlier, PG&E has a pilot with BMW where they have actually used 94 vehicles that are plugged in at home, at various points, and a collection of second life EV batteries at one of the BMW's buildings in Silicon Valley to aggregate those together and try to come up with the minimum 100 kilowatt bid into a demand response event. They successfully responded to -- I read an update on it this morning. Something like 126 out of 138 demand response events, something on that order. And in that case, actually the majority of the demand response was coming from the stationary batteries. I think only about 20 or 30 percent came from the EVs. Now this is a small pilot, 94 vehicles, but still an interesting one. And we think a useful model to look at as something that might be scalable.

The new SDG&E pilot that has just been approved the first part of this year, will actually feature hourly dynamic prices posted a

day ahead. So this is taking, you know, time variable rates to a new level. And drivers can actually use smartphones to set the limits within which they want their vehicles to be charged and respond to those hourly rates. This is going to be a really interesting pilot and something to watch closely to see just how much this approach to controlling charging, just using an hourly rate tariff, how much that will give SDG&E control over fine tuning the behavior of vehicle charging.

So in summary, if we integrate EVs proactively and intelligently, we think that we can minimize new investment in the grid infrastructure, optimize existing assets and extend their useful life, enable greater integration of variable renewables without needing new gas generation for dispatchable capacity and reducing curtailment of renewable energy production. It would obviously improve energy security, reduce petroleum consumption, reduce emissions, reduce electricity and transportation costs, and provide multiplier benefits from

increased money circulating in the economy, by providing ancillary services such as frequency regulation and power factor correction.

However, it is important to get out of this, get out in front of this and do it right because one of the other findings from SDG&E's pilots was that you only have a pretty limited window to train up EV drivers on when they could charge their vehicles and after that they get habituated. So you got about a month after somebody buys their first EV to get them thinking about how you want them to charge their vehicle. So this is why we are trying to put this message out now and get utilities, and regulators especially, to think about getting out in front of this because we acknowledge in the report, look, 0.16 percent of the cars on the road are EVs right now and EVs are 0.7 percent of the sales. We are not even at one percent on either one of those things. But it's important to get it right before we have millions of vehicles on the road that we are now trying to move around. So if we do it

badly and reactively, we think it would actually have the opposite effect on all counts. It would reduce the life of the grid infrastructure components. It would require greater investment and peaking capacity, probably from natural gas. It would make the grid less efficient, less stable, less reliable. It would increase the unit cost of electricity and inhibit the renewable integration on the grid, as well as increasing curtailment of the existing wind farms and solar farms and increase grid power emissions. So we think that even though it is very early in the days of EVs, it's really important to get this stuff right. And those are my main messages, thank you.

(Applause) Do you want to do questions later or --

MR. ALMGREN: Yeah. We'll take the questions later.

MR. NELDER: Okay.

MR. JARAMILLO: Great, thanks for having me today. I noticed the fortuitous placement of

the lectern, which is between the two rooms behind me. Did somebody point that out already? That this is the storage room, and that's the electrical room? So this must be the electrical storage room.

So no, it's great. I always look for battery jokes wherever I am. So yeah, it's great to be here today. Tesla, of course, is probably best known for our cars. And it is the topic of this particular discussion as regards to the penetration on the grid. But I primarily deal with the battery side. So I've been at Tesla about seven years and have been working on the grid connected batteries that entire time. So this is a project which has been culminating in the background for some time and really the reason for it is that it all ties into emission and for us those products are really coming together. And I'll talk about sort of the consumer point of view and why that's the case.

But the underlying mission of the company overall is to transition really the globe

to sustainable energy. That's the fundamental reason why we are doing this. It's not to build cars per se. And it's not to build batteries per se.

The Tesla history just very briefly. Of course, we are a young company operating in two very old industries. I've done a lot of work with Daimler over the years, and they are very fond of reminding us that they are 125 years old and invented the automobile. And that was to sort of put us in our place. You could have similar comments come from the utility industry, frankly, that they have been around for a hundred years and invented everything that we're currently trying to do today. So it's always a good reminder that as a technology company, you are coming into very established industries. The products that we've brought to bear in the automotive space are, of course, the Tesla branded vehicles, which people are generally familiar with today. Maybe less familiar with the other vehicles that we provide the power train for. So we started doing this for

Daimler in 2008. That was the smart car there. The little car on the left, and then subsequently moving to larger cars, the Rav 4 and the electric B Class which is currently being produced in Rastatt, Germany today.

Those two latter cars used the complete power train from Tesla. So power train includes the motor, the gearbox, the battery, the power electronics, the control systems, the thermo systems -- everything that makes the car go essentially, the mode of system. And the experience that we got out of that very much informs the work that we do on the grid side. If you take those components and you subtract basically just the motor piece, you have a stationary battery. And in fact, if you add in the point right to the motor, you have a three phase AC bi-directional

(inaudible) and that's really the grid interface point. And so that's what we do on the automotive side, and how we are thinking about

it on the grid side.

As far as other ways in which the cars are interacting with the grid, of course, is the charging. So all cars come back to charge at some point. They must by definition. And this is just two maps of some of the work that we've done to build our own charging stations. Customers want to be able to charge easily. They want to be able to charge conveniently and overwhelmingly that means charging at home. So far more than 90 percent of all charging in our fleet happens by people coming to their garage or their carport and simply plugging in and walking away.

When you ask them how long it takes to charge, they say five seconds. Most of the charging just happens overnight while they are sleeping. That said, people do want to drive long distances, and so we did enable a much larger network for high powered DC charging. So these are stations conveniently located off of highways and rest stops, where you can pull in and charge for 20 minutes. Get half your range and continue

on your way. If you look at the number of stations that we have installed today, this is still at very low penetrations of the vehicle overall. So in the United States just for reference, we are still shy of 100,000 cars, and we've built close to 400 stations here in the United States. And many of those stations, especially the ones actually right near Washington DC, are heavily used, especially during peak periods. We have our own peak demand issues with respect to the stations that we've put in.

So when we think about very high penetration scenarios for electric vehicles, still we think most of that charging or vast majority of it will happen at home, and therefore will require, of course the distribution system to be able to support that. But we do see a need for high power charging stations to exist throughout the driving areas that people might be interested in. Whether Tesla continues to invest in that in the same that way that we have or whether other entities do that, third parties and providing

those services is still to be determined. But certainly people use these stations. They do drive long distances, and it's one of the compelling reasons why people will buy an electric car. If they feel they are artificially constrained in terms of range, then that makes the selling proposition that much more difficult. So this is some early indications for what we sort of should be contemplating in very high penetration scenarios.

Ake mentioned some of these numbers earlier, but we think about sort of the collective fleet of the cars that we have in the world. I mentioned shy of 100,000 in the U.S. Globally, it's around 150,000 at this point. And what that means in terms of energy storage that Tesla has deployed -- about 10 gigawatt hours of rated battery capacity, more than 40 gigawatts of power electronics are on the grid with now I think close to 3 billion miles driven. The million car experiment, just for reference that's five percent of the passenger vehicles, registered passenger

vehicles in the state of California. And if you do that -- sort of equivalency math in any region, those ratios hold. So ten gigawatts represent about 20 percent of the system peak in the CAISO. So about five percent of EV penetration represents about 20 percent of system peak, wherever it is. And so when we're still in the very low penetration scenarios, like what Chris mentioned, it doesn't take much frankly, to get to very high impact scenarios on the electric grid. And that's why we do need to pay so close attention to what we are crafting in terms of tariffs and rates.

And I think the other thing is that all the cars of course can be connected. They are adjustable. They are controllable. We are doing some work to look at how we would control the charging systems, putting power back onto the grid is a whole level of complexity. We're not quite yet ready to engage the vehicle to grid. There is questions of warranty on the battery. There is questions of just sort of customer awareness. And there are questions of value. Is it worth it to

sort of bother the customer to recover 30 cents a day maybe in terms of value that you can get out of that, 40 cents a day, that depends on the market. We think at this point not quite yet.

So what we do think is going to happen -- I'm going to skip some of these slides here, although they are interesting. There is a big battery plant that we are building. What we do think is going to happen is that we will see a convergence of the distributed energy devices. So as people buy electric cars, I think it was Commissioner Peterman in California, she uses a phrase that "electric vehicles are the gateway device for energy literacy," which is a great way to think about it. And we see the same thing happening. So when we talk about high penetration EV scenarios sort of by definition what it also means is high penetration of other distributed energy resources. Our customers go out and get solar. Our customers go out and figure out how to manage their thermal loads. They really do start to gain the literacy and then engage. Probably

the simplest way to think about it is, anybody can tell you the price of gas today. Very few people can tell you the marginal cost of electricity that they pay. But once the gas, once the fuel is electricity, they very quickly figure out how much they pay for it. And they start to figure out how to engage with their utility, with their available rate plans and with the options that they have there.

They also go out and do things. Like they want to be able to add batteries. They want to be able to control their load, and they like the idea of making their own electricity on-site and fueling their car with it. It is a very sort of, it is a natural way to think about it. And in the very high level penetration scenarios, it is important to take that into consideration.

That said, we can't violate some of the basic (inaudible) principles when we are crafting the tariffs. And we can do things like have hourly. We could do five-minute time pricing, if we really wanted to, but simplicity has to be

there. And so the simplicity -- if we can't get it in the tariff directly, then it will be abstracted at some point by a service provider to the customer because they will just say, you don't worry about all of the stuff that's happening in the wholesale markets. We will reconcile that with your ultimate payment. I mean, utilities do this today, right? You can get a levelized payment for the entire year and the utility will just reconcile that for you to -- so you don't have to have a much higher bill in summer, a much higher bill in winter depending on what your utility is.

And so I think something similar would happen. If we get too complex in the tariff directly to the ratepayer in the case of electric vehicles. But the other part of it is that once you do have this suite of technologies, and I haven't mentioned solar yet, but solar is a large part of the consideration. You have solar. You have batteries. You have electric vehicles. You have other devises in the home. Those devices

will very much participate in the grid. And they will be the best thing that happened or the worst thing that happened, depending on how we take those into account from the system tariff perspective.

I actually maybe gave you the wrong presentation. So this was intended to be the last slide here. There are some beautiful pictures. There is some nice stuff here, but we are very proud of this project.

But I'll end on this one here, which is basically our vision of the future which is those things that I mentioned -- solar panels on the roof, batteries in the house, electric car in the garage, and those devices connected via a suite of technologies that are all interacting here and very much participating in the grid. So that's what I wanted to leave you with. We see this being very much the future. Across all jurisdictions, the interest in electric vehicles is great. We are very excited about it. And we think it is going to be very much a part of the

distributed energy future, which is sort of the macro-trend that's pushing all of this together. Thank you.

(Applause)

MR. ALMGREN: Tom.

MR. DOUGHTY: Thank you Ake, and Sue and Pat, thank you. Everyone, thanks for having us here. My first time before this group, excited to share some developments in California with you. When I was called to join in this conversation, so what are we going to talk about? Are we going to talk about the Aliso Canyon natural gas leak, the ISO's regional efforts? And it was electric vehicles. I said, thank God. Something we can put into a bucket and manage.

I was speaking last week at UCLA and a couple hundred people maybe in the audience. And I started with this question. I looked out and there were folks who were long in the tooth like me, and then some young kids, and I said, "Who here is a student?" And about 40 percent of the room raised their hand. And I raised mine, and I

kept it up, and I said, "I suggest to you that every person in this room right now is a student of a new generation of power supply." And this electric vehicle conversation we're having today is one of several components that really define this brand new reality. Ake and I were talking beforehand about some of the developments in California. I'll cover them, but we are really in this incredible moment.

My son just graduated from UC Davis, and he asked me, "Well, should I go into central station energy, distributed energy, regulatory, legislative?" Yes. Because this moment is truly a transformative period for us. You see that my title of my graphic here is Driving to Transform Our Society. And I chose that specifically because the ISO has had a recent epiphany. We are not trying to simply electrify the grid. We are trying to enable what we all seek and that is a carbon-free economy, a carbon-free society. So let's talk about that, frame it out. Big changes in California now, you have seen it in a number of

times -- 20 percent renewables by 2010, rather; 33 percent by 2020; and now 50 percent by 2030. And as you may know, rooftop solar, hydro and nuclear don't count against those GHG reductions. There are some days now when we're getting well above 50 percent, 70 percent GHG free energy in California. So it's an incredible moment, and it's being complimented by, of course, the rise in consumer-owned power.

We have 5,000 megawatts of consumer owned power, rooftop solar in California. It's growing at 11,000 installations per month. So just process that for a minute, the magnitude of that, 11,000 installations per month. That's between 50 and 70 megawatts per month of rooftop solar. Obviously driven by rates, California's electric rates are quite high. My electric bill last month was $775, and I don't live large. It's expensive and rates and then California's green preference are driving that. The potential for consumers to aggregate and participate is also a transformative momentum builder in California.

I'll talk about that in a minute. And then the discussion around electric vehicles, 231,000 is what I understand now, 7,600 charging stations. The state of our state of renewables can be brought down to some very simple terms. On our 65,000 megawatt system, we have 19,000 megawatts of renewables. But our system is 65,000 megawatts of peak capacity. On a spring or fall day, we might be down in the 25 or 30,000 megawatt range. So now hold on -- a 30,000 megawatt load, and you got 19,000 megawatts of utility grade renewables on that system.

So just really join me in a really quick exercise. Let's just say it's a 28,000 megawatt load day. We have -- call it 14,000 megawatts in renewables. Back it down a little bit, just for the sake of this conversation, 5,000 megawatts of imports and 12,000 megawatts of fossil gas for us. We've backed that fossil fleet down as far as we can. We can't turn them off because we need them when the ramp kicks in later in the day. So I'll do the math for you, 28,000 megawatt load, 31,000

megawatts of resources, what do we do? We curtail. We curtail renewables. And that curtailment is becoming deeper and deeper, as more and more utility grade renewables are being brought online. It doesn't take a political science major to know that that is not sustainable to be turning off in effect billions of dollars of assets that should be used to reduce carbon in California. So we're expecting another

to 10,000 megawatts of additional renewables to meet this 50 percent objective. You can see that our problem deepens very, very quickly.

We've all seen the duck. The bottom of the duck is basically where we've backed that fossil fleet down as far as it can go and then suddenly the afternoon comes. The solar begins to fade, and we have that giant ramp. We are seeing 10,000 megawatt ramps now. 13,000 megawatts expected just in the next five years. Here is the magnitude of the challenge. In 2024, up against a 40 percent renewable standard -- of course we know

we are moving to 50 percent by 2030 -- but against a 40 percent standard, each dot depicts one hour of renewables curtailment. On the left of the scale, megawatts, total megawatts of curtailed energy and across the bottom, months of the year. Take a look at that spring period. That's pretty incredible how many hours of curtailment we expect. And then look how big it is. 13,000 plus in some of those hours. Those are huge numbers that need to be managed. And my message today is, electric vehicles can be one of the solutions that can get after this.

We see synergies between EV deployment and renewable integration. Let me just click these off. Obviously, energy storage, electric vehicles, there is a synergy there. Demand response, we heard about that from Chris earlier. System frequency response, electric vehicles can respond very quickly in times of a system contingency or a potential contingency. Consumer control -- we heard earlier about aligning TOU rates with system conditions. That is a critical

element. And I agree with what Mateo said. We've got to find the right number that entice consumers to care. Somebody told me, and maybe it was EEI I think did this study, consumers think about their electricity nine minutes a year and that includes the time that they pay their bills. That's a paradigm we've got to change. Of course, electrifying transportation and fuels is an important part of our solution set here, whether it be hydrogen or power to gas in other ways, we see a significant element there.

Notice how I indicated maybe on the regional coordination. Some of you may know that California is seeking to begin working with other western states on a Western RTO. There may be an opportunity for a coordinated electric vehicle deployment and utilization program there. And I've listed three other areas in our solution set of this challenge we have over generation. Energy efficiency -- targeted energy efficiency may be a word that's new to some. Energy efficiency across the entire day does not help the duck curve.

Targeted energy efficiency during times of the day may be a benefit. That noted, that definition is still really undeveloped, and we've got to do some work there. We've got a lot of stuff going on in California. Chris mentioned some. Mateo mentioned others. I won't try to go through all of this. There is a tremendous amount of development work going on -- technology pilots, market pilots, regulatory and legislative developments, a whole bunch of stuff underway in California to get our hands around the needs that the grid has, the opportunities that electric vehicles represent to help meet those needs, and the challenges that we've got to overcome to get them across the finish line.

I drew this on my piece of paper. I don't have it as a graphic. But what we are trying to do, is we're trying to decarbonize the -- draw a circle. Join me in a circle here. Decarbonize the electric grid, you know, utility grade renewables. Decentralize the grid with distributed energy resources. Electrify other

sectors using that plentiful clean power that is now coming from these two contributors and then enable the electrified sectors, vehicles being one but building stock being another and there are several others to then provide grid services back to the grid. And what a beautiful world that would be, if we could de-carbonize and draw this circle back to where our society begins to reap the benefits, not just the electric grid element.

The last graphic I have for you. We see empowering electric vehicles as being three things -- technology, basically the linkage between vehicles and the grid or distribution system, whatever it may be. We see market design and rates being a significant driver and then consumer preferences and ease of use.

These are people ultimately that it comes down to. And Ake mentioned one of my past lives. I was part of this group that in 1989 said, "Let's go start electric vehicles." Now imagine how crazy that statement sounds today when we have beautiful vehicles being manufactured and

used. But in 1989, if you said the word electric vehicle, honestly, people would say, "So do you attach an extension cord to it when it's driving?" We laugh now, but those kind of questions were prevalent then. We built in Los Angeles a prototype electric vehicle, the automakers, the major automakers were showing hesitancy in moving forward. So we said we are going to take this vehicle out on the road, Frankfurt, Tokyo, Turin, Los Angeles, Detroit, the major auto shows. We took that vehicle on the road to try to create this reality that this vehicle runs on batteries.

It's such a wonderful moment for me to be here now years later and talking about vehicles no longer just as a transportation alternative, but as a grid alternative for making our grids more resilient and stronger and more cost effective. These are programs that the ISO has got underway to enable vehicles to aggregate and participate. I won't bore you with the details of them. Suffice it to say, we are committed to it. We are bullish on electric vehicles. We want to

turn that 200,000 to 2 million to 7 million as fast as we can. And I think the work that we are going to today will help enable that. So everyone thank you so much for having me today. (Applause)

MR. ALMGREN: Watson.

MR. COLLINS: I enjoyed the discussion here. What's great about this is, this is a pretty exciting topic for utilities to be involved in with electric vehicles because, you know, it's not often that utilities have a product that we are going to be really proud of to deliver to customers. When you look at this it's a much cleaner resource for utilities, for transportation sector. And for people that look at like ground level emissions and stuff, there is significant benefits to communities around electric vehicles. And also we know that the fuel cost is going to be a lower fuel cost for consumers. So this is another great thing for utilities. And this flexibility that a lot of the presenters spoke about, that's really the reason that makes electric vehicles different than other end uses.

There is a flexibility. The cars are parked 23 hours a day. They are only on the road an hour a day when you look at the statistics.

You've got plenty of time to charge them when they need to be. There is so much flexibility in how we integrate these vehicles into the grid. So that's really the exciting part of this, and what's going to happen over time with this. And then also there is the cool factor of this, you know, people love cars. I mean, people love talking about cars. I love talking about cars. It's an exciting thing. So for my presentation, I'm going to go through two things. I'll just talk a little bit about what we've done, and then I'm mostly going to have three slides that I found other people presented. I'm using other people slides. I'm sorry, but I thought they were really good in just talking through some of the key issues. So here is a little bit about our service territory. I won't spend time on that. But, you know, we spent some time. You know, I got involved in this, in the late, around

2008, 2009.

And the first thing we really wanted to do is to understand how these vehicles, what is this whole thing and what is the impact on the distribution grid? So frankly, we looked at a lot of studies that were published out there. And our two conclusions that happened in that first phase focused on understanding impacts. We saw the studies that were done out there, Oak Ridge National Labs, I think did one, and a couple of other labs did. And we saw that this isn't an issue on the bulk supply system of integrating vehicles. We are not going to have to build power plants to supply the resources for these electric vehicles. That was a great finding and great understanding. And you'll see a slide, a future slide, it helps put that in perspective.

And the second thing we learned is that it's really, you know, how do you, the assets, the utility assets that are closest to the customers, that's where the impact is going to be. And I have a slide that really talks through that also

too. The second thing we started doing is we started doing pilots. And this is an example of a, there is a little cut sheet on a pilot we were doing up in Massachusetts of how we are trying to integrate vehicles into the grid. And what's interesting about that is we're trying to use -- what's great about vehicles is two dimensions we can use to manage and integrate vehicles into the grid. That first dimension a lot of people talked about is time. So you got 23 hours. You've got 23 hours to charge the vehicles. But also the very interesting thing too with the vehicles is, there is not one way and one speed to charge these vehicles. They can be charged in one-and-a- half kW, up to 20 kW, and then even at this DC fast charger stations, they are

and 100 kW chargers. I'm talking because there is an electricity group. I'm using some of the technical terms here.

So we're trying to use in our pile there those two dimensions to integrate vehicles in the grid. So we've looked at a lot of -- and I'll

talk about the, you know, the approach when you just look at time of use rates and that time dimension to manage vehicles.

And then the third thing we've done is a lot of education outreach. We have a campaign around Plug My Ride and the website plugmyride.org for customers, and we participate in a lot of events. But moving forward, I think there is six areas we are kind of very interested in. And this first one is how to integrate these vehicles for residential charging. We talked, you know, 80, 90 percent of the charging for these vehicles is going to be at home. So how do you go about doing that? That's like a big question and there's people that have -- there is ten different ideas, maybe a hundred different ideas on how to do that. And so there is a great topic and a discussion around what that is, and we have opinions. And I think other people have opinions and there needs to be a lot of work on that.

The second topic I call it open vehicle grid integration. There is a lot of ways to talk

about this. It's a little bit around the standards around how the cars in the grid are going to talk together. One of the automakers, Daimler, is a big proponent of a standard, called ISOIEC 15118. California Utility Commission just adopted that standard as how they want to integrate vehicles. And they've got a very innovative approach to how the utilities and the cars and the consumers are going to be able to get the information to make all these decisions around how to best charge these cars. So that second area is what's that standardization, that platform that's going to happen there? These next three areas are really around the infrastructure. And it's the, you know, assets on the ground that are going to, you know, do the bulk of helping get these cars charged.

The lesson learned is we know that home charging works. People are figuring this out. It's not a big hurdle for customers to charge their cars at home and to get the infrastructure set up at home. These other areas that I

mentioned here around workplace and the fleet where there is longer dwell times, you know, the times that the cars are parked, that's an area. The multi-unit dwelling infrastructure is a challenge because you know it's not just single family homes where we can put the charging infrastructure where we have opportunities. How do you enable this long distance travel with DC fast charging, getting power into the cars quicker so you can be more mobile and do more with your cars? And all around this -- and it's probably an overlapping thing around this, is how to enhance interoperability because we want -- cars are mobile. They are going to drive across state lines. They are going to drive across utility territories. We need this to get built to be working regardless of where you are in the country. So that's really the goal.

So here is one of my other people slides. I'll start out with the first one here. So we were looking to see what are the grid impacts and ISO in New England, Connecticut and

ISO in New England, New Hampshire and ISO New England. And so we are working with Idaho National Labs, and this is the 2013 low profile that we have in those top colored set of lines and the, you know, obviously time scales going along the horizontal axis there. What you'll see in the bottom is this is an overlay of the data that Idaho National Labs has done with -- they have been collecting data on charging patterns. They know how -- like if there's a 1000 cars in an area or 5000 cars in an area, they know what the load pattern looks like. And so they modeled adoption scenarios for how that compares to ISO in New England's service territory. And what you see is there is this set of bumps down the bottom of this curve here. And the first bump is a five percent penetration of EVs. The second bump is a ten percent. And the third is -- the higher one is the 20 percent.

So let's talk about those numbers for a second. We have less than one percent of sales of EVs today. And I'm talking about sales. This

number is a percent of the stock of vehicles and it takes, it will take ten or fifteen years of one percent of sales to achieve a one percent penetration of the stock. So you are not going to hear a lot of anxiousness from me around how we are going to integrate vehicles into the wholesale grid because I'm not - it's a math question. Diversity happens. We as utilities deal with diversity even though somebody is charging maybe 10kW, there is diversity. People don't charge every day. They come home at different times. This diversity effect happens, and this is how the whole utility grid works. There is a diversity effect that happens. When you switch the light off, you know, a power point doesn't turn off because you switch the light switch off. There is other things going on in the grid. So that's the biggest lesson, and one of the great interesting slides I've seen from other people's slides.

My second interesting slide from other people is this is the capacity thing of charging that I was talking about. So this is from

Sacramento Municipal Utility District. And they did a study, and they said, you know, there's different ways to charge these cars. You can charge it at one-and-a-half kW, which is one of those bottom lower set of curve, that lower curve, which is 120 volt charging and this 3.3kW charging is kind of the more typical charging pattern for a lot of the plug-in hybrids in the smaller battery vehicles now. And the charge rates are increasing for the bigger battery vehicles. They are coming to market at 6.6 and 9.6 kW charging. But what you see in the trend there is they figured out the average, the annual upgrade costs that they are going to have to make on their grid based on these penetration scenarios, which is really the year, you know, it's a higher penetration. It is a shortcut for the -- the year is a shortcut for the higher penetration scenarios.

And you can look at the different costs that are going to be incurred on the utility grid, the distribution grid. This isn't, you know, this isn't the bulk supply distribution grid that

accommodates these vehicles. And what you see is a general trend. Oh, and I should say that the hash lines that pair up with the other, like the blue series, the hash lines are a time of use rate on top of the 19.2 kW. So what you see there is that the upgrade costs are really trending more around the capacity of charging. And so you see why I did my pilot, I was trying to manage the capacity of charging on the grid because I'm trying to learn how to minimize these upgrade costs we are going to have to do on the grid for higher levels of penetration.

And now the third thing, my third interesting slide around this is -- it's around California and time use rates and the customers are responding to time use rates. The date is profound that even on very little price differentials in California -- with minimal price differentials they are responding to time use rates.

The challenge has been to get customers to participate in the rates in the first place.

And what I find fascinating here is, for folks that may not know California's rates that well, they have these inclined block rates and which means the more power you use in a month the higher your per kilowatt hour rate is. And so they have per kilowatt hour rates that get near, you know, over 30 cents, approaching 40 cents a kilowatt hour. And once you get into those kind of pricing -- electric vehicles may not even be competitive with gasoline vehicles. And so they had a policy issue that they had to address immediately around electric vehicles to help support this market. And so even with, you know, I know the guys at Southern -- I know the guys at all three utilities well, but Southern KLS, they do some great marketing around their time use rates. They've got, what is it? I can't see the percentage there. It's less than 40 percent of the customers that participate in time of use rates.

So it's -- I know there is a lot of talk around time of use rates. But we're looking at this and saying, well we have to find something

that is easier for consumers to participate in because this doesn't appear to be the easy button for consumers today. Maybe there's improvements that could be made in it, but it doesn't look like it's the easy button for moving forward.

So I guess, you know, to wrap up my comments here, I was throwing out a set of questions of how to wrap this up, and it's really targeted around what are we trying to accomplish when we look at integrating vehicles into the grid? That should be, you know, like as we are trying to understand what problems we are trying to solve when we look at solutions? You know, I'm just proposing that our solutions should be based on, you know, what problems we are trying to solve. And so here is a set of questions. I don't know if you wanted to use those, but I appreciate your time, thank you.

(Applause)

MR. ALMGREN: Thank you. Watson, that's a nice lead into our questions. You almost set up the next session which is the questions and

answers, and then I think in the sake of time we have

minutes, so I'd suggest we open up the floor. If you guys are running out of questions, I have prepared some just as a backup, but these two likes to start.

CHAIRWOMAN TIERNEY: That was a really great panel, so thank you very much, and it's really exciting in terms of the vision of the future, and as I was listening to all of your themes I kept coming back to a number of points that you made, and I don't often do this but I'm going to give you my "N of 1" case study and then ask whether or not this kind of challenging issue comes up very often.

We used to be an end-source customer in Chestnut Hill and moved where we had a plug-in electric vehicle and we had flat rates. It was awesome. Moved to Denver. Sorry, lost your customer -- where we have panels on the roof, and we bought a house with a 20-year PPA from a third party. You don't have retail choice in Colorado,

but you can have third-party PPAs.

So we have a light, nice, virtuous cycle and by the way, customers who have that combination like my husband do not have to have a PhD and work on this stuff. He's interested in electricity for the first time in his life. We don't have a Tesla battery, and our garage does not look like that picture. (Laughter) We have crap everywhere in our garage, and we still plug it in. It's great.

So, my question is this. We have flat -- we have metering in Colorado. I'm on a 20-year PPA. Most of my electricity is sold to Solar City, and I have a net payment that I'm doing to Excel Energy. I'm on a 20-year contract. How representative am I of the customers who are now locked into some cycle of pattern of using electricity for 20 years given a contract that existed there, and I want to use the timing issues?

My husband is on the record. My husband does have a PhD, but it's not in this stuff, and

so he says, well -- right now I say plug in in the middle of the day. He said, "What are you talking about? Plug in. Why would we do that?" Of course, the sun is shining. He doesn't get it. He does now.

So, how representative are we of having these legacy things associated with rate design, associated with contracting, associated with the incremental pieces that we put together and this vision of having it all be kind of an integrated unit? Is it Solar City that becomes the aggregator of my load to charge at different times? Is it Xcel, because I have no interest anymore in theory because, again, I'm on a kilowatt-hour, 20-year contract without any timing issue, so I'm in this to be illustrative, not to say how dumb the Tierney's are, but it's a question.

MR. ALMGREN: Mateo?

CHAIRWOMAN TIERNEY: You can tell us we are dumb.

MR. JARAMILLO: No, no. I mean to your

question, how representative is it. It's very representative because that's -- there's a million solar homes in the United States. I don't know what the number is exactly, but the majority of them are under third-party financed systems. That's starting to shift in the market overall, so now you see the loan products being more and more popular and people just owning it themselves and then all the freedom that goes with that.

But what you will see is as rates change that hopefully not as drastic as what happened in Nevada where the NEM meter was removed entirely even un-grandfathered. Of course, that's been restored. As the market will change these third parties do have an incentive to continue to maximize the value of that asset that's on your roof, and they may, for example, offer additional services or see reason to add a battery at some point. Now with grandfathered them in place, likely not, but the market is dynamic and things will change, so I think it looks like maybe it's fixed for now, but I would suggest that it's far

from that.

Frankly, that things will change so dramatically in the next few years, five years, ten years, whatever it is, that there will be cause to revisit a lot of the structures that were put in place previously simply because these assets are valuable and they will see value in the market, and if we structure the markets properly and assuming that's the case, then you'll see every chance to sort of change that kind of thing, and the consumers are asking for it as well.

MR. ALMGREN: Watson, would you like to add to that?

MR. COLLINS: Oh, sure, sure. And as you well know that people say -- had a lot of comments around utility rates and I always say, like, they really reflect public policy, you know, like, because the other issue, the dirty issue that gets brought up around electric vehicle charging is there's going to be demand charges at some point.

You'll hear this discussion around

demand charges for these DC fast chargers, and I always say, you know, certain parts of the country have strong demand charges and other parts don't have very strong demand charges, and it's really around the public policy that was put in place in those areas that said, you know, we want to make sure that we're minimizing our investments into the grid. We want to make sure the signals are sent to consumers so that they're integrating to the grid in a way that doesn't require additional utility investment, so the utilities have public -- because I hate getting questions about demand charges and having to, like, we don't want to have to deal with those questions. We wouldn't volunteer -- we wouldn't sign up for this, and it's -- so it really reflects a lot of public policy objectives, and so I think those public policy objectives are really at play right now around how electricity's going to be priced to consumers.

I think that there's a lot of interesting opportunities that you're going to see

around people aggregating loads, and I think there's going to be some activity around auto makers aggregating loads because if you look at -- I mentioned this ISO, IE-15-118 standard. What's fascinating about it is it doesn't require the customer to make daily decisions around these charging patterns. It's trying to say if I drive to work and the price of electricity is X, the car decides I'll charge then, and it understands that the car needs to get so many miles a day, and it understands the state of the charger when it plugs into a station and how much it needs.

And so, I think there's evolving standards that are (inaudible) makes this seamless because consumers don't want to minute-by-minute, hour-by-hour decide whether they want to buy electricity. They want that option to know it's there, but I think they need an interface as you talked about; an interface to make it simple for them I think is really the objective.

MR. DOUGHTY: I would agree and if I could offer an observation. I mentioned when I

was speaking that this really comes down to people; consumers' preference, and Sue told a story of a family of consumers and their circumstances.

In California we have a system we call the Flex Alert. It came into play after the energy crisis of 2000-2001, and we've used that during times of system duress. Power officials ask that you use less energy today. Consumers have become accustomed to that. Now power officials ask that you use more energy today but not tomorrow.

(Laughter) To your point. It has to be something like this or like what you folks have developed in other parts of your vehicle that make it completely effortless; set it up and walk away, and capitalize on the value that it represents.

MR. ALMGREN: Okay, I apologize, but I'd like to go over here to Billy.

MR. BALL: Yes, and Watson may have

actually already answered this with his previous comments. I was going to ask Chris -- I was listening to your conversation. Several people mention charging at home, but I look at your graphs and the San Diego example, I guess I was struck with, well, it looks like really when you need them charging, that's when a lot of these vehicles, I assume -- I don't live in San Diego, so I don't know -- aren't at home. They're in somebody's parking deck. They're in somebody's parking lot, and I was just struggling with how is all that getting wrapped together?

I mean, it may be -- it sounds like the answer's what Watson said, just to make the vehicle so smart, but even then for it to be smart and know, it still has to have -- still has to be connected, I would assume. And this -- I don't know if when San Diego with the efforts there is it -- how have they wrestled with the vehicles aren't kind of at the convenient location, or maybe they are. I don't know.

MR. NELDER: Well, that's very astute.

Absolutely true. One of the things I really didn't have a chance to cover in this presentation and we do get into it in some detail in the report is the fact that the right solutions are going to be different in every place and every utility and every state.

So, San Diego desperately needs vehicles plugged in the middle of the day to soak up excess solar power when it's getting curtailed. The opposite problem is going to obtain in places like North Dakota where they need the vehicles plugged in at night to soak up excess wind.

And so that's going to be a matter of rate design, I think in our opinion. This is where the regulators really need to offer the right value proposition for charging companies and for consumers to have the vehicles in the right place at the right time, but this raises the point that to really enable this EV revolution we need to sort of work the problem backwards. We need to think where do we have the excess power and the high prices? How do we make sure that we have

vehicles in the right places to plug in at those times and to offer these good services by charging or not charging at the right times?

And then what does that mean for how we get chargers placed into the right places where the vehicles will be, and I actually have a diagram I probably should have thrown into the slide deck where I actually mapped out all the different stakeholder groups. There's about 12 or 15 of them and all the different activities they need to participate in together to make this EV revolution happen, and it's daunting once I mapped it all out because we have a lot of stakeholder groups that are not accustomed to working together that are going to have to work together to make this work.

We need utilities talking with local officials at building and planning departments, and we need auto makers working with utilities, and we need customers working with building owners and so on to do all these different things to really get the chargers in the right places at the

right times. But, no, you're absolutely right.

That's a key issue here, and I think the best that we could offer at this stage in our analysis was just to sort of highlight the issues and then say, okay, you regulators, you utilities, you different state officials, try to think about this and where things need to be.

Something that Ruben Munger who's an RMI board member and involved in the private charging company space made an interesting point to me toward the end of our report. We actually built a little sidebar into the report just to capture what he said because I thought it was interesting, which was right now our policies and the way that we're getting charging stations deployed sort of presumes that everyone needs to charge and plug in at night, but what if that's not actually what happens?

What if we actually start getting the deployments in places like San Diego at shopping centers and work places and people charge up there, especially if they have access to level-3

chargers and it only takes 20 minutes and they get home and instead of needing a full charge overnight they just need a 10 percent top-off? What does that do to all the planning that we're doing here and our conception of how this charging infrastructure gets laid out? So, these are important questions and I think the answers are going to vary from place to place.

MR. ALMGREN: Thank you, and next is Phyllis, and by the way, Phyllis was very helpful in getting this great panel together.

MS. CURRIE: Thank you. The time I spent at Pasadena Water and Power we had a lot of interesting electric vehicles, and we saw first of all -- there was some issues around the planning and permitting of charging stations that you mentioned, and I just wonder -- I think Watson, did you see any consensus developed among the various planning officials in your service territory about what's required to get a charger in place?

And then the other thing that we saw was

that at- workplace charging -- and there was a lot of that -- you had situations where people would go to work, plug in, but leave the vehicles there, and then other people who had vehicles couldn't charge or they were getting into disputes about someone leaving their car, so did you see that in your area?

MR. COLLINS: Yes, I mean the great thing is the early days with these charging stations -- again, I've been -- ended up bit of time here. Frankly some of the equipment wasn't UL approved, and there were a lot of issues and so these building inspectors were having a hard time, and it was the first time they were seeing this infrastructure. So there were a lot of challenges.

Granted, what's great is that it actually very quickly the building officials and the code enforcement officials learned this very quickly. A lot more of the equipment became UL approved, then it became just more of like a very check-the-box endeavor for building officials.

And the second thing that happened that's kind of interesting to me, too, is I've commented about these level-

Charging stations and these guys would know. Tesla would know well, too, there's probably $50, $100 worth of stuff inside that charging station. Some of those charging stations sell for $6,000, and so what's happened in the residential area is those price pressures have really been felt in residential area, so you can buy a $380 charging station now for your home, and so it's UL approved and so all the typical industry pressures have come to bear on residential charging which has been great because it's made the residential charging work now. It's not a barrier which is great.

MR. JARAMILLO: Yes, just one comment to that. I mean what we use (inaudible) the term charging station more properly speaking should be just a connector. That's really all it is. It's basically like a -- plug anything in, so it's wire.

However, initially some of the car companies tried to take cost out of the electric vehicle and put it into properly a charging station, so they did take the charger out of the car and they put it into a $2,000 piece (inaudible). They then had to pay for it incrementally to make the cost of the vehicle cheaper. That's now all gone, and that (inaudible) happens. Every car company includes a charger in the car. Tesla always has, and now we just deal with connectors, and connectors are something that electricians know very, very well, so permitting should not be a problem now. We don't find it to be a problem anywhere.

I didn't mention it, but we have a separate program called Destination Charging, and this is basically enabling charging to happen at hotels, at national parks, at any place somebody might want to go and spend a couple hours, not

grocery stores, not shopping malls, not that kind of thing. Sort of at the edge of where people would want to travel. Tesla provides the gear and people use it, but they pay for the electricity. They pay for the installation, that kind of thing, and that's proven very popular as well, but we don't encounter any problems with permitting these days. We don't encounter any problems with just sort of the ease of getting the gear installed.

MR. ALMGREN: Thank you, and Paul?

MR. CENTOLELLA: I want to expand a little bit and maybe get a little bit more specific on some of your earlier discussion about the automation of charging. I mean, I'm an average source customer and I'm in Newton, and I have a plug-in vehicle. Probably don't have room in my little garage for a power wall. I barely have room to get in and out of the car once I'm in there.

MR. JARAMILLO: You can put it on the outside of your house. (Laughter)

MR. CENTOLELLA: But I drive in and I

may be concerned about can I get the pizza in the house while it's still warm. I'm not going to go sit and look on my phone about what time does the rate change and when am I scheduled, am I going to need to car again, and therefore what should I set up? How close are we to getting something so that my car will just know I need it again at 8:00 this evening. The rate structure or perhaps more importantly getting down to a world where we're getting into at least my retail supplier knows what the wholesale price is at different intervals and maybe or maybe not is also using my car's charging or not charging to provide some ancillary service. It just happens because someone knows what my schedule is from my phone. Someone knows what the rate is and the car just does it at the most economical time optimally without my having to go in and figure out a schedule, and taking this to DOE, I mean one of the roles DOE has had has been in development of interoperability standards, and I know you mentioned the 15-118.

I'm not sure how close that gets us to a

world where that happens automatically, and so I'm curious about what are the remaining standards gaps and what are the remaining technology gaps that would get us to that world where it really is I don't have to think about it? It just happens at an optimal time?

MR. ALMGREN: Watson, would you like to take that?

MR. COLLINS: Yes, so there's been a bit of -- since I see it on the frontlines a little bit, there's a bit of a competition and competing ideas around where's the hub of this. I'm just going to use Smart charging for the lack of a better term, or VGI is the term that's used for this concept, and it's a bit of competing ideas on where that resides. Does that Smarts reside in the charging station or does it reside in the vehicle or does it reside somehow with the utility, and so let's take those three areas.

For it to reside in the utility, I get actually nervous if that Smarts resides with us because we have like 99.99 whatever percent

reliability, and that's how we manage our grid. A lot of these Smarts involve controlled technologies communication systems that don't quite have that same level of reliability for consumer-level communication systems, so I don't want -- so what am I trying to say? I don't want to be the guy that's paying for a car that's charged at 8:00 in the morning as a utility guy, so I'm very nervous about us being the hub of the Smarts, frankly. So, what's that mean? We've got to send the right incentive signals and approaches to the marketplace. We've got to help guide that discussion.

The other way you can approach that is -- the charging station of the vehicle, and my "ah-ha" moment of where I said, oh, this way makes sense to me was frankly in Boston, probably two months ago it was. There was a big Smart charging workshop, and BMW was presenting their pilot that Chris was talking about, and what was fascinating to me about that is what BMW said. They know they have to put whatever, 50 miles a day into the car,

and instead of trying to be Smart with each charging session at home and work and they can be Smart about the charging sessions of when the car's plugged in during the day and overnight, and this is how you would do the -- have the cars charged during the day.

If this intelligence is built into more the car approach as opposed to the charging station, you have much more flexibility to integrate the consumer preferences, the driving patterns, the information that's going to be available from the automakers. It's a much better way, and then they're motivated to make sure that that car is charged up when somebody shows up and wants to drive out of the driveway at 7:00 in the morning. And so I think they have the right incentive to do it, and I think they have the right information do it, so I think it's -- I think it will work.

MR. ALMGREN: Mateo, would you like to add to that?

MR. JARAMILLO: Oh, yes, absolutely. I

think the car companies are the ones that have the consumer connection. It's a consumer topic, and furthermore all the processing capability's already in the car to do it, so it's really just an interface-presentation issue. The cars currently today from any manufacture give the customer the ability to set the charge time and the charge level generally, and so it's a very -- relatively it's a very small step from there to having that sort of be automated and taken input let's say from a rate that might be there, but we absolutely think that it should be from the car side.

MR. ALMGREN: Any questions?

MS. LANEY BROWN: I have two questions. When I think about customer behavior I think about marketing, and when I think about marketing I think about segmentation, and I'm wondering if as you've looked at maybe near term opportunity, have you looked at segments that may be best for grid optimization and how to potentially target them?

That's one question, and then the other

is I think there's a bit of a chicken and egg around investments and infrastructure in charging stations, and I'm wondering how much information is available or could be made available for people to -- whether it's utilities or others to be making decisions investment-wise on best ways to go about making investments?

MR. DOUGHTY: Very quickly, one of the pilots I didn't cover in my sheets because of time was a fleet vehicle pilot we've got going on with the Los Angeles Air Force Base; 600 kilowatt total combined load among the vehicles, sedans, truck, vans, non-tactical, non-military -- just service vehicles. Partnership between DoD, Southern California Edison, Lawrence Berkley Labs, ourselves, bi- directional B2G and they are bidding into our market now regulation, so obviously there's a sweet spot.

Mr. Ball mentioned a minute ago that -- what about these vehicles that are dispersed, spread across a wide geographic area? Certainly they may be virtually connected, but in this

particular case we found success in physically connecting them to a central hub, so obviously fleets are a significant opportunity. I'll leave it to these gentlemen to talk a little more about other sectors that might be suitable.

MR. ALMGREN: Chris, anymore?

MR. NELDER: Somebody yesterday mentioned that she was having trouble holding onto a thought, and I just wanted you to repeat that last question because that just happened to me.

MS. SANDERS: Yea, no problem. So the segmentation was the first question, and then the second question was information sharing about charging usage and how available that might be to help drive investment.

MR. NELDER: Yes, and I guess one of the hottest questions in this area is who should own the charging infrastructure and how much of that should be left open to the utilities to own or even to rate-base charging infrastructure versus just providing a make-ready location for third-party charging companies to come in and

install or own and operate our charging infrastructure.

This is a really fraught question. We didn't want to take a strong position on it. I will say that in California, once again there are a number of useful opportunities to observe different ways of approaching this, so all three of the big RUs in California have taken a different approach to this question.

San Diego Gas and Electric and Southern California Edison have both managed to get their charging infrastructure programs approved by the CPUC. PG&Es first two proposals were rejected, and now they're coming back for a third attempt to get their charging infrastructure plan approved.

In each of these cases there's going to be a different approach between just providing a make-ready location, actually installing and owning and rate-basing infrastructure versus being actually just a sole provider, and I think we're just going to have to wait and see how it plays out as to what regulators and the public really

deem to be the best approach.

In my personal view if I could just venture a personal opinion, I think having utilities deploy the charging infrastructure is the fastest way to go. Whether that's in the best long-term interest of the consumer I think is probably the question that's above my paygrade.

MR. ALMGREN: Clark, Jim, Janice and (inaudible).

MR. GELLINGS: Thank you. Mine is mostly a comment, not a question which will save you some time. Chris, I wanted to compliment you on your project with regard to looking at the environmental impacts, and I think that report coupled with Carl, the one with NRDC did begins to lay to rest the question as to whether the debate out electric vehicles is one about elsewhere-emission vehicles or zero-emission vehicles, and let's all continue to work on that subject.

But my comment really has to do with the device that you're referring to. Electrified

transportation is really part of a portfolio of what we might consider beneficial electrification technology, so it's really a whole host of things that we could do to further the use of renewables in various ways, controllable to some extent. Some not as good as vehicles in that regard, but there's a whole host of electro-technologies that are more efficient in that and therefore in many cases, if not in all cases, would actually be in that environmental positive.

I wrote a book on this called Saving Energy with Electricity and I've also -- EPRI's got at least one report that's publicly available; talk about what these technologies are. I just like us all to keep this in mind that this is really about electricity, and there is much more we can do technically with electricity than we're doing so far as a society.

MR. ALMGREN: I agree with that. Jim?

MR. LAZAR: Thanks. I've asked Chelsea to put a graph up during my comment. Paul, what you need is a simple urgent charge or economy

charge button on your screen and let the Smarts take it from there. Short of that I think getting the car to actually read your mind to know how soon you need more capacity may be a technology that Tesla has in the works, but they haven't announced it yet.

One of the big challenges to workplace charging is rate design. Obviously for workplace charging we want to fill part of the belly of the duck here, kind of from 10 to 12 p.m. That's the middle of the work day, and most utility rate designs to commercial customers have demand charges of 10 or 12 or 15 dollars a kW, which means for a 6kW charger that employer is going to paying $60 or $80 bucks a month per charger, and that EV is only going to use about 200 kilowatt hours a month, so you're going to wind up with 35 cents a kilowatt hour for the demand charge and 10 cents an hour for the energy charge at a time you'd actually like to get rid of some electricity on a solar-rich grid.

And it seems to me that one of the

things that we're going to have to address if we're going to encourage workplace charging is moving those demand charges into the on-peak and critical-peak energy charges, and with the California Commission has ordered some of the California utilities to begin doing it. (Inaudible) told them move 75 percent of their demand charges into the TOU energy charges, but it seems to me that for the workplace charging to work suppressing the demand charge impact on at least the controllable charging piece of the load is an important element.

MR. ALMGREN: If I could just make a comment. I think 400,000 school buses would be the ideal fleet to have electricity.

MR. NELDER: I just had a thought that I actually wanted to give for Paul's question earlier. I think aggregators have an important role to play here in terms of controlling when vehicles charge, and gathering intelligence about when customers want to charge and when they're open to their vehicles being used as a

demand-response asset and they're actually directly controlling the chargers, the role of aggregators here I think is kind of underappreciated.

There's a company, for example, called e-Motor Works that has a new little thing called the Juice Plug, and you can just stick it between the vehicle and the wall or the vehicle and the charger and it will provide a demand response service. It will provide data basically going back to this aggregator that could actually provide some real useful intelligence on that, and there's some machine learning stuff that could come into play here eventually. It's all a little bit early to say.

Even the SDG&E pilot with their advanced day-ahead hourly rates, they're going to have to hand roll their own little Smart phone app to control this because it's still -- we're nowhere near a standard situation here. We're nowhere near even a general understanding of what capacities and functions these kinds of

intelligence applications need to have, so it's still pretty early.

But I would also point out that one of the reasons we thought it was important to get this report out now is because in a place like SDG&E territory, they already have a problem with potentially overloading distribution-grid equipment.

A modern EV can consume 30-kilowatt hours a day. That's basically equivalent to a house. If you're in a pretty well healed neighborhood in San Diego or Palo Alto, it's not out of the question. In fact, it already happens where over the course of a year suddenly four or five EVs show up in a neighborhood. Well, that's like dropping five new houses on a little distribution feeder, right? And that could overload your equipment, so even though on a national basis or on an average basis we're still at low numbers in terms of EV deployment. In those particular places it's already an issue in managing the distribution grid, so these are not

academic questions about when these vehicles charge and how do we control them and what are the necessary intelligence and machine learning and telemetry and data exchange and all that stuff that has to be in place to make it work.

MR. CENTOLELLA: And it's precisely that last kind of use case that I hope people will think through, and to the extent that there are any gaps in the -- particularly in the interoperability standards which is an area that DOE as well as the National Institute of Standards and Technology has been active in, that we begin to identify those and figure out how they get fixed.

MR. ALMGREN: Janice?

MS. LIN: Thanks, Ake. So, great panel. I'm thinking -- listening to all of this I'm trying to think of opportunities for DOE and I have a couple. I'm not sure if the first is in scope or if the second is even doable, so we'll try it, but one of the things I have observed both in hearing you all speak and also as an

EV-charging user -- I am an e-motor-works customer, have an e-motor-works charging station at my home. It's enrolled in Pacific Gas and Electrics DR Pilot for EVs. I have solar on my rooftop, and I work in a building that has an EV charger, but guess what?

The tariff structures that were available to me as a consumer (a) were so super-complicated -- I would say I'm an above educated consumer and it was still really complicated for me, but when I ran the numbers the sad thing about all this after all that investment is it made no financial sense to me to go into the time of use tariff to do the separate metering, so I remain on a tier tariff with all of that at home, and I still charge at home at night when I should be charging in the day, and it's kind of sad.

But what I wanted to illustrate about my personal use case of one is -- oh, and by the way, when I bought the car the dealer knew nothing about tariffs, knew nothing about how to explain

the total cost of ownership, and he really didn't know anything about the state level or federal rebates either.

And so, what I was thinking might be an opportunity for DOE, and I don't know if it's in scope, is to help this really diverse group of stakeholders. We're talking about car companies, EV-charging equipment companies, aggregators, the solar community because a lot of EVRs also have solar, and one thing that's interesting, like, at our PC in California we have a different docket for everything. We have a storage docket and we have an EV docket, and then we have another one for the general rate case and kind of a separate rate case for NEM, and when you think about --

MR. LAZAR: And one more for demand response.

MS. LIN: Thank you. There's a silo for everything. And storage in general, but EVs in particular is kind of a silo buster across all of these including like NEM residential retail rate docket and commercial rate docket because the

person is going to drive from home to work, and I just wonder if there's a role for DOE to think about a way to do rate design around EVs that accelerates EV adoption, simplifies this for consumers, and shares different ideas and maybe even brainstorms ideas with a select group of stakeholders on how we can simplify this and make it clearer to the end user and maybe come up with ideas, but I don't know if that's in scope, but that would be super cool.

Perhaps there could be money, like outreach money that once that's done to help educate the dealers themselves because they're kind of in a lot of cases the first touchpoint for these EVs, and now that we're going to get much cheaper EVs on the market, hopefully they'll be many, many more interactions, you know, that if nothing else just clarifying how the federal tax credits work and stuff like that. It's just really I think not very well understood.

And then my second idea that I thought about, and I'm thinking about, like, Tom and all

the system operators and all those millions and bazillions of cars that will be on the road hopefully super-soon is on -- building on your comment on the data accessibility, and it seems to me that there's like a wealth of data and where these cars are charging, their power level, when they charge, but these data sets are private. They're kind of either owned by the car maker, they're owned by the aggregator, and wouldn't that be so super-cool if the system operator could at least have visibility of where this is happening at a nodal or geographic level on an anonymous basis? So, maybe it could be anonymized and wouldn't it be cool if there was like a little button where somebody might show up at a public charging station and have the superman person's like "I want to charge my car and I can't," and they just push this button, and they can do a little point of screen display that says -- and I have this car. So you cannot only collect information about existing charging, charging habits and timing of it, but where you might need

to plan new infrastructure, and if that data could be brought together and made public, that would be super-helpful, I would say, to the operator, to utilities from a distribution-planning standpoint, to aggregators, innovators, the tech companies that are inventing the cool named app for how to get into the space.

But that data access and availability I think will be really key and also helpful for your grid interoperability standards. I don't even know if the car companies would allow this, so those are my two ideas and I'd welcome your thoughts.

MR. ALMGREN: Is it okay if we go over?

CHAIRWOMAN TIERNEY: Three minutes over.

MR. ALMGREN: Maybe a little more, Tom?

MR. DOUGHTY: Just a quick response, Janice. Thirty second response here, then we can chat for just a couple more minutes. Some of you may have seen -- we wrote a vehicle-to-grid roadmap two years ago working with the California Public Utilities Commission, the California Energy

Commission. Now, things move fast and two years sounds like a lifetime ago, but many of the principles in that roadmap are still valid, and in light of what Janice just said, as I was flipping through it today and kind of re-familiarizing myself with the document, there were 28 pilot projects depicted. This is two years ago now. Now take it -- all the projects we discussed here and others that are out there, I couldn't agree more, Janice. We have this beautiful mix of pilots that are generally disconnected. The data is not coming to a central hub and there may be an opportunity for the Department to help bring some of that data together.

MR. ALMGREN: And Marilyn?

MS. MARILYN BROWN: So increasingly in the public policy circles around the country we're being asked to consider issues of equity, and we in the public policy arena often divide these into distributional equity, participatory equity, and corrective equity, and there are all kinds of -- all three of those apply to these EV questions

that we've been considering.

I'll just look at the distributional equity issues in the interest of time, but we've seen with solar PV on rooftops, big issue of NEM where participants are being subsidized by non-participants, and participants tend to be higher in income than non-participants, so definitely a distributional equity issue there.

But for electric vehicles I am suspecting there are some of the same issues at play. I haven't read much about it, but I can imagine it to be the case, and I, too, am a user of all these things. I love the rates that I get, but what about those non-EV owners who are having perhaps to contribute to the upgrading of distribution systems that are needing to be strengthened to absorb large penetration levels?

I'm very concerned that we're heading toward a utility business model of the future where all of the wealthy have their own systems, thank you very much, and the utilities are now serving a largely disadvantaged low-income

population that are dealing with what's left. So, what are your thoughts?

MR. ALMGREN: Any response?

MR. NELDER: I can address that in part. All three of the RU's in California, for example, with their electric vehicle charging infrastructure proposals to the CPUC are required to deploy a certain percentage of those chargers in multi-unit dwellings and in low-income areas, so the CPUC, at least in California is really making sure that it's trying to address at least some of that distributional equity question.

How it happens in kind of the writ large, I think is an important question and something we ought to think about, but if you really believe that we are headed for a fully electrified fleet eventually, and I think there's a really strong argument to be made that that's the case or at least in 90 percent electrified fleet.

Then I think the important question is, well, how do we get there quickly, and everyone

will ultimately benefit, and it's certainly a big part of achieving our climate goals. I don't know of any other way that we're going to address the emissions from the transportation sector nearly as effectively, so there's a trade-off maybe there as well.

MR. ALMGREN: Anymore?

MR. COLLINS: I had some comments and probably for the sake of time, do we have a second or --

MR. DOUGHTY: Sue gave us until 11:45. Let's see how tough she is.

CHAIRWOMAN TIERNEY: And she's so tough. Okay, a quick response.

MR. COLLINS: Quick response, so there's a perception out there because I'm involved in some of the discussions (inaudible) talking with policy makers. There's a perception of -- that the EV drivers are wealthy because the statistics say that most of them earn $125,000 a year or more they're buying EVs. Or I'm not to pick on Tesla or the rich Tesla owners, right, so there's that

equity thing, the elephant in the room, right, and so I think there's a couple ways that this distributional equity is being addressed though because Chris mentioned as we electrified, there will be downward pressure on electric rates for all consumers. That's an abstract thing, so it's not concrete.

The second area is that the greenhouse gas emissions profile is much beneficial, but I think the most important thing has to do with who benefits is in urban communities the statistics around conventional vehicle emissions and the impacts it has on frankly, death rates, and as childhood asthma rates and some really negative health impacts, it's around urban communities and people that live close to where the vehicles are driving, and so I think EVs address that distributional equity thing because it's going to help those communities because they're not going to be exposed to the emissions hazards that are from the conventional vehicle, so I think that's --

CHAIRWOMAN TIERNEY: That was worth hearing.

MR. COLLINS: Okay, thank you.

MR. ALMGREN: Thank you. These were excellent topics so I'd like to thank this excellent panel.

(Applause)

CHAIRWOMAN TIERNEY: Well, as you guys are packing up we really do thank you for that terrific panel, and I want to make just three announcements. One of them is the Storage meeting is on. Where is Merwin? I understand that it is not on -- oh. Okay, there is a change in the last hour. It's not on. Okay, never mind. Probably there will be a never mind about the next one, too.

We have one person signed up to speak. Is Jeremy Bedine here?

MR. BEDINE: Yes.

CHAIRWOMAN TIERNEY: Okay, great. Okay, so we're going to turn to you later for comments; not quite yet, sorry. So, thanks. I just wanted

to check, so that was not a never mind which is great.

And then the third thing is there are sign-up sheets outside for EAC members. If you would like to sign up for any of the new work product efforts that were discussed today, please look for the sign-up sheets for those and don't leave without signing up, so that would be great.

All right. We have two more Subcommittee updates, and then we're going to public comments, and then we're going to adjourn. So, Anjan?

MR. BOSE: Okay, so this is Grid Modification Initiative Working Group, the GMI Working Group, and just to give you an update of where we are, but first let me just summarize where this is coming from.

You may remember the sequence of events that took place over the last couple of years is that we had the QER which had something about grid modernization and there was a chapter on that.

The QTR happened after that, and that

had quite a bit of material on grid modernization, and then in the initiative itself, so the Grid Modernization Initiative was set up and the DOE and this is more than OE. It's actually across the OE with OE and EERE and ARPA-E and Office of Science and everybody else, and the first thing that came up with was the Multi-year Program Plan which was presented to this group, and then there was a call for a proposals to all the labs and it was named the GMLC, and these projects have all started now, and there's about -- there's several categories of projects, the foundational research projects, but I'll say something more about in a minute. Then the cross-cut research projects, the regional partnerships, and then a whole bunch of more projects that are program- specific. Program-specific means there are some program in DOE that's supporting those projects specifically.

About $220 million with about 80 projects were given out and have already started. I'm addressing the foundational projects a little bit more because what the working group did was

add the PIs for each of these projects, the six foundational projects, give us webinars on those six, and the foundational projects (inaudible) by looking at the subjects of each of these projects. You can see that they're sort of over-arching look at a very complex subject from about all these different viewpoints. What are metrics for grid modernization, what should the architecture look like, what about the interoperability between transmission and distribution and every other analytical technique that you have and how do you set that up? How do you test these things? Is there an open source library full of tools that you can access the valuation of the different services and technologies, and then looking at what you can sense and measure which is sort of the kinds of things you need to have data for.

And so, one of the observations I'll make here is that all of us that listened to these webinars saw the obvious overlap between these areas, and as you can imagine -- so one of the things that these projects have to do is to

actually coordinate a lot among themselves, and on top of that the DOE has to set up its own way of coordinating and managing these different projects.

This is also true of the cross-cut projects, and if you see the variety of cross-cut projects you see why they're called cross-cut projects. They go from interoperability standards to technical assistance to PUCs to things in the middle like how do you integrate EMS, DMS, BMS and so on, so technical, non-technical, all kinds of things that go across regional partnerships that many of these are kind of looking at specific projects that are in particular areas.

So, here's what we are planning to do, and that's my last slide. So, the plan is to come up with a report to the EAC for the March 2017 meeting, and we'll ask for your approval at that time. The target date was set mainly to coincide with the new administration starting and the need to stress the importance of the grid modernization issues and the complexity of these issues, and

this goes back to the fact that this particular initiative took a lot of doing and it only started a couple of years ago, and we felt that it was necessary to not lose momentum on this because the GMLC was -- that is the lab call for projects was really the first part of this whole initiative, and it was supposed to be followed up with more research calls to a wider stakeholder set of people like universities and private companies and so on because the only -- all the research that is being done under this initiative right now is all led by the national labs, right? And so it's sort of unlikely that these other calls will go out before the new administration takes hold, and so the idea was to make sure that we don't lose momentum, and hopefully the report would help doing that.

And then, of course, specific things, recommendations about where the initiative stands today. You know, I mentioned this thing about the coordination management of the existing projects. What are the areas in which to cover the gaps that

are not covered today? Also how do we adjust to changing realities, and in this -- by changing realities I think most of us mean that as time goes on the policy arena keeps changing which changes the way you look at what you do on the grid modernization, so the policy technology connection kept coming up in our conversation so much that you have to keep a very close eye on that.

So the report should cover all of that. It's not going to be a very long report, but it's going to be one that would stress essentially the importance of the issues, so that's my report.

CHAIRWOMAN TIERNEY: Terrific. Does anyone have any comment or question? I think that's going to be a very useful report. Marilyn, is your card up?

MS. MARILYN BROWN: No, down.

CHAIRWOMAN TIERNEY: Okay. I didn't think so. Thanks, Anjan. All right, we have one more presentation; an update from the Clean Power Plan Working Group.

MR. ZICHELLA: Good morning, everybody. This should say Clean Power Plan Working Group, but, well, pass that up for now.

This whole project so far has been sort of cloaked in uncertainty given the political realities of the Clean Power Plan; how it's been tied up in litigation. In fact, as you all know, the DC Circuit just heard the case day before yesterday, so what we tried to do is try to understand what's being done to aid compliance even as this uncertainty is out there. There are still activities going on among states to try to figure out how they plan to address this. I think a lot of states would rather have some sort of their own programs rather than default to a federal program eventually. There's still work going on. It's just not clear what it's all going to look like.

So, the Subcommittee's had a number of calls during which we tried to get our arms around what we should be focusing on. This seemed like a much bigger issue when we started, but now I think

we're coming back around to trying to at least take stock of what's going on among both public and private institutions to help states figure out how to address clean power plant compliance.

One of the things we wanted to do is not tell DOE to do what it's already doing and to try to understand how the agencies were interacting with each other and putting together their programs, and also noting that there are a number of activities in private institutions also that needed to be looked at.

Some of these things could wind up creating competing platforms of modeling tools and the like, and we wanted to understand exactly what was going on. So, we decided to do a couple webinars. I've been working with Caitlin Callaghan to sort of structure what these things will be in our team from ICF, so we've planned to put together two; one looking at public agencies, the other looking at private institutions and NGOs that are working on clean power plan compliance approaches.

We've planned one webinar for October 28th. It's open to everyone in the EAC, and one will be scheduled after the election in November to look at the public agency issues. The format for the private sector webinar is pretty much the way we've been doing these; panel discussions have some basic presentation time and then open to question and answer from participants. We're having them look mostly at what the multi-state compliance work is that they've been doing, and we've got a good lineup of people from a variety of different experiences to help us go into this.

Among them, David Littell of RAP, Jim Sculley, and thank you, Jim, for helping us connect to David. I've seen some of the webinars that David's done for other groups including state (inaudible) regulators; really good stuff. I really looking forward to his presentation. David Hoppock of the Duke University's Nicholas Institute, Robbie Orvis from Energy Innovation, and what the tool that

Energy Innovation has put together is sort of a policy-evaluation tool. It's a little bit of a different take than the kind of modeling work that we've seen from perhaps Nicholas, but also from Colorado State, and this tool, I think, has some very interesting features that should be useful. And finally Patrick Cummins from The Center for the New Energy Economy, Colorado State University; the (inaudible) Institution former Governor Bill Ritter established at Colorado State and they've been working very closely with a number of Western states on clean power plan compliance approaches.

The public sector webinar is going to take the same format, of course, and we're looking at three agencies at this time; DOE, FERC, and EPA, and as I mentioned we hope to do these

sometime after the election before the holiday season. That's all I have actually. There's a report right now.

Hopefully we'll have more information coming for you, so watch your email about more information about especially about the November webinar. And the timeline and plan going forward is after we have these two webinars, sort of regroup with the Committee again and sort of see what the context that we're working in is going to be next year and try to come up with -- if there is a product, what it might look like in terms of advising the Department. Again, we want to make sure that we're proving useful advice and not telling folks to do things that they're already doing, so that's my report.

CHAIRWOMAN TIERNEY: Thanks, Carl. Does anyone have any questions? Yep, you're good. Thank you. Now, we have one more item on the agenda before we adjourn, and I am pleased to call Jeremy Bedine to the microphone. And please introduce yourself. This is the public comment

period, and we're very happy that some member of the public has comments.

MR. BEDINE: So actually egg on my face because I thought that the public comment sheet was to have an opportunity to provide public comment to any documentation that's released post meeting; nevertheless I'll use the pulpit that I have for a moment, and I won't take up too much of your time.

So, my name is Jeremy Bedine. I am here on behalf of academic work that I'm doing at John Hopkins University in the Energy Policy and Climate Program. I'm in a group within that program that is drafting an energy plan for the next President. An area that I'm really focused on is grid modernization and extension. My career background; I spent about 10 years within the energy sector. I was a renewable energy project developer for the Department of Defense for about two years developing utility-scale projects on U.S. Army installations. Prior to that I did consulting with the Louisiana Public Service

Commission on the viability of renewable portfolio standard, and I did a lot of private sector work helping enterprise organizations cut their cost of electricity through both a mix of onsite EACs energy -- excuse me, ECMs, energy conservation measures, as well as gaining a better understanding of the market and where electricity pricing might go.

So, nothing that I have to say because I didn't prepare is particularly brilliant and it's only going to be for a minute, and I think pretty much everything's been said at one time or another within the last two days here, and I've been in and out. But I do want to touch on a few of the highlights from the standpoint of somebody who's researching this from a university and having these discussions with a number of professors in the program who are looking at the same things.

Data availability -- so as we from kind of academia are going in and looking at how we can contribute to all of the work that you're doing and all of the challenges that you're struggling

with, data availability is the central challenge. The availability of data on, for example, yesterday we were listening to a very interesting discussion on optimizing load through time-synchronized analysis. That data, NREL was able to obtain it, obviously, but that data is very difficult for people within the university environment to obtain, and there are a surprising number of people who, if they had access to data like that, would be able to really make use of it and contribute to driving some of these solutions forward at relatively low cost to all of you.

Permitting complexities -- I say this from my experience trying to build large-scale renewable energy projects for the Department of Defense, and a number of them were successfully developed but -- and these were touched on yesterday as well. The permitting complexities that result from a fractured system of regional utilities and RTOs all separately managing and overseeing their domains and poorly coordinating with one another becomes a major hurdle in

addressing the next set of challenges that are going to need to be addressed not only with large-scale transmission and being able to make optimal use of renewable energy to transport it to load centers, but also to putting in place broader solutions that are going to enable states to coordinate with one another and really save the rate payer a lot of money over the long run even though some of these solutions are going to have a high rate impact on the front end.

And the last thing that I want to touch on and I don't know -- I didn't hear it while I've been here. I don't know if it was discussed in any of the times that I was not here, but standardization or at least some relative level of unification of the standards that guide the type of equipment that's selected and how different transmission systems are constructed, and the example that I use is transformers. Eighty-five percent of our transformers are imported and custom made, and studies show that if a large-power transformer is put out of commission as a

result of an electromagnetic pulse or some other type of event, you could be looking at a lead time of as high of almost two years. I know -- and for anybody that lives in the metro D.C. area during DERECHO -- I lived in Bethesda -- I didn't have power for a week, and that was a small substation transformer that took us out.

So, as we look at how we're going to solve this next set of challenges and how we're really going to transform the grid of today to a grid of tomorrow, go from a line to load model to a more nodal model, the standardization of equipment and the standardization of components for the grid is going to be critical to being able to have a higher level of energy security and to be able to ensure more affordable power and more reliability for the consumer.

That's all I have to say on this, and then if I ever do have an opportunity to write my public comment I'll be happy to, but thank you for letting me voice it.

CHAIRWOMAN TIERNEY: Thank you, Jeremy,

for your comments. Keep of the good work. We'll look for your comments on other things. Thank you.

(Applause) So there is one more announcement from

Merwin, and I'm going to be heading out because I have to go to an NAS meeting with Anjan, so if you would then close it out. Bye, everybody.

MR. BROWN: Thank you, Sue. There apparently has been some confusion about whether there's going to be a meeting on the high penetration energy storage work product effort because the plans have been changing fast. There will be a meeting. The working group has commandeered the program here and so they're going to meet. They're not going to miss this opportunity to get together. We're not sure where yet. There's exploring the possibility of still going over to AES like before, but we may stay here. We may go out on the curb under an umbrella, but we're going to meet.

And anyone who is new or even those who

have been here at this Committee a long time and want to join, you're welcome. As a matter of fact, you're encouraged to join us, so just wanted to make that clear that that's what happened. It's technically 1:00, but I think we want to convene as fast as we can probably grab lunch and get back here.

MR. ZICHELLA: Okay, thank you, Merwin. That concludes the agenda. Does anyone have any final comments for the good or the order that you're just burning to say? If not then in Sue's place I will adjourn the meeting until next time. We have for those of you who haven't put them in your calendar yet, the dates for the upcoming meetings are on the screen. Take note and hopefully if you can, book them now -- block them now rather. So, thank you all very much. It's been a really great meeting. Really appreciate it.

(Whereupon, at 12:12 p.m., the PROCEEDINGS were adjourned.)

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CERTIFICATE OF NOTARY PUBLIC

COMMONWEALTH OF VIRGINIA

I, Carleton J. Anderson, III, notary public in and for the Commonwealth of Virginia, do hereby certify that the forgoing PROCEEDING was duly recorded and thereafter reduced to print under my direction; that the witnesses were sworn to tell the truth under penalty of perjury; that said transcript is a true record of the testimony given by witnesses; that I am neither counsel for, related to, nor employed by any of the parties to the action in which this proceeding was called; and, furthermore, that I am not a relative or employee of any attorney or counsel employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

(Signature and Seal on File)

Notary Public, in and for the Commonwealth of Virginia

My Commission Expires: November 30, 2016

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