UNITED STATES DEPARTMENT OF ENERGY

ELECTRICITY ADVISORY COMMITTEE MEETING

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PARTICIPANTS:

JOHN ADAMS
Electric Reliability Council of Texas

LYNN ALEXANDER
U.S. Department of Energy

AKE ALMGREN
ORKAS Inc.

ELLEN ANDERSON
University of Minnesota

WILLIAM BALL
Southern Company

ANJAN BOSE
Washington State University

CAITLIN CALLAGHAN
U.S. Department of Energy

PAULA CARMODY
Maryland Office of People's Counsel

PAUL CENTOLELLA
Paul Centolella & Associates

RICHARD COWART
EAC Chair

PHYLLIS CURRIE
Midcontinent Independent System Operator, Board

DOUG DAVIE
Wellhead Electric

RACHEL FINAN
ICF International

VICTORIA GANDERSON
U.S. Department of Commerce

PARTICIPANTS (CONT'D):

CLARK GELLINGS
Independent

PATRICK HUGHES
National Electric Manufacturers Association

HONORABLE PATRICIA HOFFMAN
U.S. Department of Energy

CHRISTIAN JOHNSON
U.S. Department of Energy

BENJAMIN KALLEN
Lewis-Burke Associates

PRAVEEN KATHPAL
AES Energy Storage

SRINIVAS KATIPALUMA
Pacific Northwest National Lab

CURT KIRKEBY
Avista Utilities

JANICE LIN
Strategen Consulting

MAUREEN MALLOY
ICF International

ELI MASSEY
U.S. Department of Energy

MICHAEL MCELHANY
U.S. Department of Energy

DAVID MEYER
U.S. Department of Energy

M. GRANGER MORGAN
Carnegie Mellon University

PARTICIPANTS (CONT'D):

JEFF MORRIS
Washington House of Representatives

TIM MOUNT
Cornell University

CHELSEA PELLECCHIA
ICF International

IRWIN "SONNY" POPOWSKY
Consumer Advocate of Pennsylvania, Ret.

WANDA REDER
S&C Electric Company

CHELSEA RITCHIE
SMRP

MATT ROSENBAUM
U.S. Department of Energy

HEATHER SANDERS
Southern California Edison

CHRIS SHELTON
AES Energy Storage

RAMTEEN SIOSHANSI
Ohio State University

JULIE SMITH
U.S. Department of Energy

ROY THILLY
North American Electric Reliability Corporation

SUSAN TIERNEY
Analysis Group

DAVID TILL
North American Electric Reliability Corporation

PARTICIPANTS (CONT'D):

MICHAEL TOOMEY
NextEra Energy

REBECCA WAGNER
Wagner Strategies

CARL ZICHELLA
Natural Resources Defense Council

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P R O C E E D I N G S

(8:08 a.m.)

CHAIRMAN COWART: Good morning folks; if you would, please, take your seats. We are ready to begin. Once again for anyone attending from outside the Committee, please be aware that a transcript is being prepared of this session. If there are any members of the public who would like to address the Committee, please make sure to check in with the signup sheet and let us know if you would like to address the Committee, there will be time available at the end of this morning's meeting.

We are going begin this morning with reports from the Committee -- Subcommittees and while those reports are happening I'd like to ask the Committee members who were at the FERC Technical Conference yesterday to think about what went on and how you would like to report, just very briefly on results of that -- of that conference. Paul?

MR. CENTOLELLA: Thank you, Rich. So,

this is the report on the Smart Grid Subcommittee. And I want to begin with thank you to our departing Subcommittee members who have great contributions, our departing Chair, Wanda Reder, Sonny Popowsky, Clark Gellings, you will all be missed on this Subcommittee, and we are going to have to fill your shoes with new members because there's a lot of good ongoing work going on. So, thank you very much for your contributions over the last few years, and your leadership, Wanda.

So, with that, let me talk a little bit about what the Subcommittee is doing and what we plan to do -- And how can I make this go? Ah, there we go. So as you will recall, we had a panel at the March session on distributed energy resource valuation and integration, that continues to be our principal topic in the Sub-Committee, that of course was followed up with the panel yesterday on transactive energy, our next steps in that process, you know, are --

Well, first of all the -- I'll talk a minute about some of the topics that we've

identified in this area, as potential topics for a work product, and we will have a call coming up later this month where we'll actually have some distribution planners from a couple of distribution utilities on the call with the Subcommittee talking about the real issues that they are encountering as they seek to integrate distributed energy resources into their networks.

We also, yesterday, had a conversation in the Grid Modernization Working Group about the fact that that working group is going to do some webinars with the lads who are involved in that work, on the different foundational projects in the Grid Modernization Lab call, two of which, valuation and architecture, are particularly important for this question of DER integration, and so we will jointly schedule those calls with Anjan's group, and the Smart Grid Subcommittee, so that we can both hear what's going on in those two work areas.

A small group of us had a conversation over breakfast this morning, you know, we are also

looking to, at some point, hear over the next few months potentially follow up on some of what we heard from Srinivas yesterday, and look in more detail at what is the potential for integrating responsive demand in buildings as a distributed energy resource into this mix.

So all of those things are now on our agenda, I think we are now looking at, you know, if we are -- if we stay on course, you know, and decide to put out a work project we are probably looking at the end of the year for that work product rather than, or prior to the September meeting, just because there's a lot to do to get through this topic and all of the complexities that are involved in it.

So, some of the issues that came up in our last meeting that we will continue to look at as we decide, you know, how to go forward and what we can and should do in terms of a work product, you know, are listed on the slide here. So, can DOE support the development of a common understanding amongst stakeholders, regulators,

policymakers, of terminology and different valuation frameworks? You know, what do we mean when we say, distributed energy resource? What are the products that distributed energy resources can provide?

You know, we heard yesterday, you know, that there are three basic electric products, you can read other reports where there are a dozen different things that people say DER have been doing. Some places you see 20 or more different, you know, alleged things that maybe they are just combinations of the three basic products, but there are things that, you know, DER supposedly can do and we need a better understanding of what those are, when there are tradeoffs between them, and how they fit into evaluation framework.

There is also, I think, basic -- I don't know whether it's a split or a continuum, but a couple of basic models for evaluation, one of which is planning an administratively based, and a second of which is market and DLMP based, and you know, we think there's probably some role in the

Department and getting people to better understand those two models and what are the differences.

Other topics that we think we might be looking at to address, is tools for and ways to evaluate the variability and time location and product-specific marginal cross and value of DER, knowing that those can be quite different.

Additionally, there's probably some R&D in tools development around a set of additional factors that can also impact DER evaluation, including the role of voltage constraints and distribution marginal losses and distribution equipment life, or transformers and other things in distribution. What's the impact of economies of scale on the one hand, and real options value on the other? How do you deal with the fact that once you put a distributed energy resource into a place on the distribution grid, it doesn't mean that you can put 10 more and then get the same value, you know, what is that impact on value look like? How is reliability and resilience, environmental impact, risk allocation, how does

all that play in to the evaluation framework?

There is also a set of work around grid architecture and control, some of this will mean, you know, continuing to extend some of the existing good work that's gone on at PNNL, but also thinking about, are there other architectural models, of course systems that, you know, that we may need in situations where our conventional approach is to security constrained dispatch are simply impractical, the Internet, given the dimensionality of having, you know, potentially thousands of distributed energy resources in a high DER environment, and what are the other kinds of tools that come into play there.

A couple of other issues that we have identified is how does DER integrate into distribution planning, forecasting into operations? Are there specific things the Department might be able to do to provide tools or resources in that area? And we've had some discussion about trying to understand, you know, what are the structural and regulatory barriers

and opportunities to DER? How can you address specific stakeholder concerns that DER might impact, though all of which could impact the ability of DER to move into the market? So these are all things that are on our topic agenda.

We'll look and see what we can address and what we are -- you know, where we think the Department is on these, and are there things that we can suggest that might supplement where the Department has been going. So, our plan for the remainder of 2016, you know, hopefully we'll get some replacement for our losses on the Committee as we get new Committee members in July.

You know, we will continue the examination of DER valuation and integration issues, including getting a better understanding of what's going on in DOE already, and considering whether and what work product and recommendations we might develop. We are expecting some response from DOE to some of the Committee's prior recommendations on Smart Grid, and we'll look at that, and I hope before the end of the year we'll

maybe get to kicking off consideration of the Internet of Things, and power systems.

You know, based on the Leadership meeting yesterday we are probably not going to do a panel in the fall EAC on this topic, which is good, because I think we are probably not going to be ready for it by the fall EAC meeting, but we'll continue to look at that for future EAC meetings. So that's what on our agenda going forward. I'll stop and take questions and we can open it up for discussion if there's any.

CHAIRMAN COWART: Comments and questions from the Committee members or others on the EAC? What do you see, Paul, as potential panel topics for the later meetings?

MR. CENTOLELLA: Well, I think this is certainly the one -- the Internet of Things, that's certainly an area we want to look at, and I think might be a topic for next year. You know, I think it's also possible, we may do something in terms of something internal to the Subcommittee this year, but I'm particularly interested in sort

of following up on this question of how the buildings play as a distributed energy resource and provide virtual storage, what's their potential, what barriers do we need to address in order to bring that fully into play in the market. Those are the two that I have in mind at this point, and there may well be others.

CHAIRMAN COWART: All right. Thank you very much. Next we'll hear from the Power Delivery Subcommittee. David?

MR. TILL: Good morning. I want to echo Paul's thanks to departing Committee, Subcommittee members, Sonny, Gordon van Welie, and others have been very important to the Power Delivery Subcommittee, and already we are getting strong input from Phyllis and others who are joining. And I deeply appreciate the opportunity, not just to have their impact with the Power Delivery Subcommittee, but I personally appreciate the impact, because it is an excellent honor for me to rub shoulders with every one of you.

Looking forward, two things I should

mention. It should be the last time that I address you in this meeting. I may have promised that before, I hope not. I hate to keep getting our hopes up, but we are getting in place a new leadership structure for the Power Delivery Subcommittee, and I'll look forward to that. The first item that the new leadership will take on will be high penetration of EV into the market.

Mr. Graham's presentation yesterday was a precursor to that with a look, an umbrella look at what's going on with EV, and then for the September meeting, we expect to supply a panel to go into more detail and specific areas of that. Then let me shift to the paper of Value of a VAr, which is not quite ready yet, but which continues to draw attention and to -- and advance, continue to point to the need for it. We'll hear, with the time that I will leave for the people who were at the FERC Technical Conference yesterday to talk.

One of the -- Well the first panel at that meeting was on the state of reliability, and in the state of reliability there was a hint of --

I view it, not a large flag, but a hint that as we go forward, and as DERs proliferate as conventional generation to shut down, whether for economic reasons, having to do with gas prices, or other things, for regulations or for whatever reason. These STATCOMs, SVCs, synchronous condensers, et cetera, et cetera, et cetera, are going to be relied on as reactive generators for the system, and they need to work, and I hope you never get the impression that I'm against these things.

I am for them. I am for their working extremely reliably, and so there is a mention in the state of reliability to one particular thing that I'll go into a little bit more detail with you, and I'll over-dramatize it just because we underplayed in the report, a bit. Several years ago, with the first STATCOM that was ever put on the system, I made a big production of taking the vendor out to the site, sweeping my right arm across the device.

I hope I haven't told you this -- And

saying, when I have my voltage collapse, and 60 Minutes comes in to ask me why I had my voltage collapse, in my now former career holding this device, and of course I was overdramatizing then too, because, do you believe for a moment that we'd put the first STATCOM on the grid in a position that it would have that effect. But these people needed to understand this. I said, I want to be able to sweep that arm across the burning, smoking remains of what used to be my STATCOM.

And as I work up a tear, saying, she gave our life -- she gave her life for our grid, but we didn't respect her big enough. But if I have to sweep my arm across the device and say, isn't she pristine, isn't she beautiful, we are so glad she cut and ran, instead of wasting herself on this grid we purchased her for. You are going to be in danger because my left hand is going to be on your collar where I've dragged you behind me, and the next thing my right hand does, is point and say, and it's their fault.

I tried to get them to understand, I don't want that so protected that it can't do its job, and this came from -- well actually it was followed by our conversation in a forum similar to this with the tents and the mics, and we were arguing about how reliable these devices were. And the Chair of the Committee had said, David, if there are any questions on this particular slide, you'll need to take them. And I said, fine, and so he threw the slide up there, he spoke to it, he quickly went to the next one. Somebody hollered, you are supposed to raise your tent, people.

Somebody hollered, wait, and raised his tent, we should not be discussing this, these are -- and the reason for that was, we were also including SVCs in the discussion of that slide. These were not new devices, we should not be discussing them, and the Chair of my Committee said, dot-dot- dot-beep. And I said, these were not new devices but they've never been adequately vetted for the application that they are in. They've been applied to prevent voltage collapse,

and never been properly vetted or tested or verified for that.

And so it started a discussion with my being the hub of the wheel of the discussion objection, overruled, objection, overruled. And so, as I'm saying telling the tale and nobody else in that room is here today, that I can see, I definitely parried every objection, and either gave a minor wound or a heart thrust depending on what I thought of the person. So that's my side of it.

One fellow keyed his mic twice, to object, and he objected and I responded to the objection. He keyed it a third time, and got recognized, and keyed it a third time, when he was recognized, and then a strange look came over his face, and he put his tent down, and said, I'm sorry I yield the floor, and killed his mic. And I thought, oh, my, what have I don't. I've offended this guy, I've chased him from the conversation and that's certainly never my intent.

And so I chased him during the first

break, and I said, did I offend you? And he said, not at all, David. I said, then why did you leave the conversation the way you did. He said, because I realized you were right. I thought, well, you know, before you kill that mic, and I'm leaving the discussion because David is right, would have been kind of nice to hear, because nobody else was believing it but me, and now you.

He said, and I realized I should have been ahead of you, because when my company first applied synchronous condensers, think about what a -- how old does that statement go back to. When my company first applied synchronous condensers, we did a very similar thing to what you are talking about with electronic devices. We applied a standard voltage protection to them, and it was the third time that they tripped when we needed them to boost the voltage, before we realized we don't need to protect those that way, they are the protection.

And so one of the things that's hinted at, in a state of reliability report, is we

started the discussion, we are starting, really, we are so nascent in this; a discussion with the industry about the protection of these, which has been left to the vendors, and they know how to protect their devices, but they don't necessarily know what grid owners, bulk power system owners, need by way of those devices protecting them.

So, we are starting an intentional and intended to be comprehensive discussion with people with the expertise to lead it, leading, but everyone involved is a wish to be, to make sure that these devices will be compatible, as they penetrate the bulk electric system as conventional general leaves in these, I'm going to call them dedicated reacted generators, take the place of the reactive piece of the conventional units that are leading.

So, I want you to be aware of that as you will soon be able to read this paper, and also for new people on the EAC, let me express that the approach of this paper is to allow four very distinct views, and one of the reasons is that

when something is wordsmithed, when something is honed to its most concise, every word packed with this meaning, and that meaning, and we understand every bit of that meaning because you and I were in the discussion where we owned that. Other people read that and they miss a lot.

So, we are trying to make sure that all of the viewpoints get their viewpoint fully expressed. And so with that, I will close my remarks, and ask if you have any questions or comments. Thank you.

CHAIRMAN COWART: Thanks for the tale, David; and also the promise of the four voices coming towards. Any questions, comments from members of Committee?

MR. ZICHELLA: Mr. Chairman?

CHAIRMAN COWART: Oh, yes, sorry. Carl?

MR. ZICHELLA: I just want to take a moment to thank David for the work that he's done chairing the Committee, and it's, as you can tell from his little presentation, it's always been a delight working with him. His amusing view of the

world of our rather technical world that we toil in has been refreshing and I've learned a lot from you, David, and I've working enjoyed working with you, thank you.

CHAIRMAN COWART: This might be a good time to hear from folks who were at the FERC conference yesterday; if you don't mind, just on an impromptu basis. Who was -- Mark and Billy?

MS. HOFFMAN: And Roy.

CHAIRMAN COWART: Oh. And Roy. All right. So, please chime in.

MR. LAUBY: You probably know, of course, there were three panels, I'm sure of that -- if Ms. Hoffman talked about that. One, was on the state of reliability. The second was part 1 and part 2; part 1 being a conversation with the EU representative, and one from CRE from Mexico, which are regulators. And they talked about the transitions going on in those two areas, and then part 2 was emerging issues, and then part 3 was security, focused around cyber and physical security mostly.

The first panel around the state of reliability, a lot of conversation around what are things that -- you know, what are some of the risks that we are seeing that keep people concerned. A lot of those focused on the security piece more than anything, else. Though, there was a number of other areas such as, you know, frequency response, and with the changing grid and they were -- even though they were really kind of looking at the here and now, there is a lot of places in North America where here and now is a place where there's a lot of distributed energy resources, and how that integration is coming along, and what are some of the needs for reliability.

Then the second part on emerging issues with the gentleman from EU and CRE from Mexico, again, more around the situation there, and the changes that are going -- most of you are aware, with Mexico, what kind of changes they are going through to develop markets, and also going toward renewable energy, shutting down all their plants,

you know, building in perhaps some distributed energy resources, et cetera, and potential for interconnections there.

And then of course the EU is kind of amusing, because it's 28 countries and no same message, so he was really speaking to his own views recognizing what he was saying, and some places in Europe they wouldn't necessarily agree with him. So, it's still very interesting, where they are and where they are going, and he started out the presentation by saying, you probably asked me here to learn about what's going on in Europe, and what you can learn from us about integration renewables. You can say that at this time you can learn absolutely nothing from us; which of course is not true, but he was very modest, and it was very nice of him.

And then the second panel was wildly successful because I was on it, and it was around emerging issues, and I think most -- really a lot of the discussion was around what I call jurisdictions; the jurisdictions between the gas

and electric industry, and the jurisdiction between, let's say, the bulk electric system, and the distribution system, more federal and state jurisdictional, and really how we are going to work those seams.

What are the needs so that we can remain reliable? And a lot of the discussion focused on distributed energy resources, and what information will the bulk electric system need when you see this transition of, let's say, the bulk of your generation coming from the bulk electric system to the distribution system, somewhat one-way to, where you see the balance start going to 90-10, 80-20, and what are the expectations to contribute and support reliability from the distribution system.

Or what information will the bulk electric system operators need from the distribution system, to understand imports/exports, the nature of the dispatch. You know, the dynamics of the central reliability service, availability, frequency response, et

cetera, digital, and that. So it seemed like a lot of discussion there, some folks said, well, there's no need for the grid anymore, and it's all been micro grids, but I beg to differ on that, I think that there's going to be a need for both, just like there is for, you know, telecommunications and computing systems and all that, that there's room for it, and a need for both, to maintain reliability.

And then the third one, the third area was really focused on cyber security, a little bit of a nod to the Ukraine and what happened there and, you know, where we are right now with information sharing, and where we need to go, because NERC has some standards on cyber security there is no information sharing over here, more operational and situation awareness, but there's a place right in the middle there were we can build the system, and we can operate the system to be more resilient. And what is it going to take to do that? So I think there's some discussion around that.

I think that's pretty much my recollections. I don't know, Roy, did you have anything you wanted to add, you were there the whole day too?

MR. THILLY: No. I think you hit it all. Pat was also on the first panel, and she may have --

MR. LAUBY: Which was wildly successful as well.

MR. THILLY: Absolutely.

MS. HOFFMAN: What was going to be my comment; was the first panel was, I think, awesome. I guess the only comment I'd add on the first panel is there was a lot of discussion around modeling analysis, analytics, and what could be done to improve the models, to improve the capabilities. That was one thing that I pulled away, as an important topic. I think you've hit all the other kind of transition issues that was discussed in the first panel. There was a compliment on the first -- the state of reliability, the 2016 report that, you know, was a

good foundation to start with respect to metrics. And then there was the last conversation, which I'm not sure, actually, it was fully developed, but a little bit on the metrics, and what are we, what are we really thinking about moving forward on metrics.

But I'm not sure we actually hit probably the breadth of that conversation, only to recognize that we have to think about beyond and minus one, to other forms of metrics given the state of potential events that could occur on the system will be different.

MR. THILLY: You know, one thing, it seemed to me, I was on the first panel, sort of that there was a very significant agreement across the panels on what the issues were. There were some minor differences and debate, but an awful lot of consensus as to what the challenges are and what needs to be done. And it was very a very comp conference, and also the relationship between NERC and FERC has improved dramatically.

MR. BALL: The only thing I would add

is, and I didn't get to see Mark's panel, which I'm sorry, I'm sure it was very good. It was interesting to me, how in the discussions, at least in the morning when I was there, and Pat kind of made this point, how much overlap, in some of the conversation, there is with the very topics that have even been discussed at this meeting and previous meetings, which is encouraging, to me, because that a lot of the topics, again, around modeling, you know, new computing techniques, all of these type things, there's getting to be a good alignment in different venues in essence about where we need to be going.

So that was actually very encouraging to me. It was also interesting to me how often the word distribution was said in a FERC meeting, which I'm sure for a FERC Commissioner is a challenge, right. So, that was the other observation I had in the morning.

MS. TIERNEY: It sounds like it was an awesome meeting, every single one of the panels. That's all I can say. What was said about the

interface between natural gas delivery capability and responsiveness to the need for really real-time, dispatching of power plants and the slowness of delivery over gas pipelines?

MR. LAUBY: It only came up, my recollection, it only came up during the panel I was on, and the question really was around standards, and is there a need for a standard where you perhaps, a unit would have to commit to saying, I'm going to be available, and therefore I'm going to have to make sure that I can available through contracts. Because, as you know, NERC doesn't have jurisdiction over the gas industry, and I pointed out that one of our standards already calls for an extreme event where you study pipeline outages.

And so that kind of took the wind out of the sails on that to a certain extent, but what I also did comment on, is that there's a great deal of work still ongoing. NERC just issued a report where we identified protocols for planners and operators in how they should address this risk,

because NERC is basically saying, industry address the risk.

You need to be available, you need to be able to balance - your BA has got to balance their systems. RC has got to ensure there's reliability, they have to work with the generating plants to, you know, put together whatever kind of protocols, how much dual fuel is needed, or firm contracts are needed, but you've got to makes sure you remain reliable and you have action plans in place for the TPL standards.

So, that's pretty much where it landed. I don't know. Roy, did I miss something there?

MR. THILLY: Well, the California storage issue --

MR. LAUBY: Yes.

MR. THILLY: -- was what was on everybody's mind; and as a quote "new risk" obviously not a new risk, but one that hasn't had focus.

CHAIRMAN COWART: Clark?

MR. GELLINGS: Thank you. I'm curious

to what extent these nasty words, one being research and the other being technology, were brought forward because, you know, we keep talking about how we are going to solve this problem, whatever the problem is, that perhaps we haven't yet, well, described to ourselves, but it does appear to that there are some technology needs, to what extent were they addressed in the deliberations.

I don't know if it was so-called addressed, but certainly it was discussed, you know, because as you start looking at the distribution system, and distributed energy resources, and technology integration for smart grids, and for micro grids, you know, you have to touch on it, but I don't know that -- I mean, I think there were some -- the conference itself focuses a lot on what's the regulatory needs.

One thing that was really nice about this particular set of panels was that each one had at least one academic, I'll say, somebody from the university, Joe Eto was there on Panel 1 as

well, along with Patricia. So, I think that, you know, did it get a firm vetting? Probably not, but I think there's a recognition that additional investments are going to be needed here to assure reliability.

You know, one of our jobs at NERC, and David Till talked about the state reliability report he helped us work on this year, has also put our binoculars on, and identify risk, and working with industry to ensure that they are mitigated and managed. So, I think a good partnership there, between the research community and industry, I think will help us make that happen.

CHAIRMAN COWART: Tim?

MR. MOUNT: Going back to natural gas, was there any discussion of the type of contracts that a generator should have? I mean that the assumption that they can purchase in the spot market when they need to seem extraordinarily, you know, dangerous.

MR. LAUBY: And one of the things that

I mentioned in my testimony and also the NERC report that was -- of course we write those with industry, is that we talk about contracts with a firm view, and how much in the mix do you need to have. You know, there's a place for spot, there's a place for firm, there's a place or dual fuel that actually works when you need it to work, and some -- you just don't necessarily have to have dual fuel. So that's something that we are expecting the BAs and the RTOs and RCs to kind of sort out what the quantities are needed of those, just the right mix. But it was definitely my testimony.

MR. THILLY: There's a sort of a tension between market rules for capacity where there's penalties, or whatever, versus having a firm contract and, you know.

CHAIRMAN COWART: Paul?

MR. CENTOLELLA: You mentioned the topic of federal state jurisdiction and how that relates to distributed energy resources, I was wondering, was there any sort of progress on laying out a

process or beginning to address that, and beginning to, you know, resolve some of the uncertainties that exist in that area?

MR. THILLY: No. (Laughter)

MR. CENTOLELLA: Okay, fair enough.

CHAIRMAN COWART: So, recognized.

MS. HOFFMAN: You definitely as well recognize. I think the biggest part of the conversation on potential role for FERC was looking at some of the seams issues.

MR. THILLY: And I think you have the same tension, jurisdictional issue with respect to adequacy.

CHAIRMAN COWART: Sue?

MS. TIERNEY: I just want to come back to natural gas again. It sounds as though the conversation mainly focused on assuring that the gas pipeline system can, and the arrangements for gas, can work from a resource adequacy point of view and from a performance, as is the case now with many of the PJM, performance improvement programs and are the same in New England. But I'm

eager to see the conversation move to also include deliverability issues around the clock, on any old day of the year, where the responsiveness to whatever existing pipeline infrastructure is in place at whatever moment, is used as efficiently as possible so that you can avoid new, where that's appropriate, but also that it will -- the pipeline system scheduling process is better tuned up with the scheduling process on the electric side.

And anything that we, including DOE, can do to help encourage the gas industry to understand the kinds of things that were being said around the table at the FERC meeting, there's a lot of regulatory and institutional space up there, that's not covered by FERC, related to the gas supply chain. And so that I think they are really important ongoing issues associated with making sure that the two industries really are moving in sync. I mean the conversation about the instantaneous responsiveness of the electricity industry to all these devices, is just so

completely different than the conversations on the gas side.

And so it's not in FERC's bailiwick, but FERC sees a side of it. It's not in NERC's bailiwick, you see a side of it. Maybe, Pat, there are things that the Office of Electricity can help with, just continuing to move those two industries together. I've spent a lot of time recently with the NASP Standards Process, which has now just resulted in a big, fat dud, in terms of having the industry, the gas industry think that this is a real issue that they need to address.

CHAIRMAN COWART: Granger?

MR. MORGAN: Yes. Sue, I think I've asked you this before, but are any of the New England natural gas facilities put in onsite store -- I mean, you can store gas, so in principle I could address this problem in the short to medium term with onsite storage next to my gas turbines.

MS. TIERNEY: There definitely has been discussion of that, and there have been several

reports when my colleagues wrote -- Paul Hibbert wrote a report for the Attorney General on looking at onsite storage, deliveries of LNG, on real-time, pipeline additions, and then dual fuel capability.

MR. MORGAN: But nobody actually built anything yet.

MS. TIERNEY: Well, and there's a proposal for a new peaking facility where the interveners came in and asked for LNG storage. I happen to have been a witness in that case, and happened to have been Head of the Siting Board many years ago, and thought that that was not likely to be able to get the siting of a satellite storage for LNG facilities in that window of time, that the capability commitment came, like a three-year timeframe. Picture how hard it is to site a natural gas pipeline these days, just picture, okay --

MR. MORGAN: Yes. I got it.

MS. TIERNEY: So, yes, as he answers yes.

MS. HOFFMAN: So, one other comment that I remember and you guys are going to have to correct me if I'm wrong, is I think there was a recognition in the meeting, in the technical conference, that we need to get some more in-depth conversations and that had to be at the interconnection level, or at a lower, you know, part of the system, and that is talking about every single part of the country, in one meeting, you know, tended to just generic tie some of the issues so much that we haven't gotten through enough of the conversation. At least I vaguely recollect that being a point brought up.

CHAIRMAN COWART: Anything further on this topic? I think we are ready now to hear from the Energy Storage Subcommittee.

MR. SIOSHANSI: All right. So, I'm stepping in for Chris Shelton, who was supposed to be stepping for Merwin Brown. Hopefully not too much of the message has been lost in translation, but --

MS. TIERNEY: Well, you look like both

of them.

MR. SIOSHANSI: What's that?

MS. TIERNEY: You look like both of them.

MR. SIOSHANSI: A combination of the two, perfect. So there are two major updates as far as the Energy Storage Subcommittee is concerned, two work products that we are working on right now. The first one is a white paper on high penetration of energy storage. Just as a little bit of background on that product, the idea behind it, or the motivation behind it is that there's been a fair amount of work recently, a lot of studies looking at what a high penetration of renewable energy future would look like, what the transition to that future would look like. What the technical challenges would be, the economic, and so on and so forth.

So the idea was, you know, why not tee up similar sorts of studies for a high penetration of energy storage future. Now this white paper is not supposed to do that actual analysis, it's sort

of supposed to lay the groundwork for that type of work to be done in the future. And the approach that we are taking is this -- I think Merwin described it as a scenario-based approach. He updated the Committee at least two or three times, I think, on this over the past year, or year-and-a-half. And so the idea is, we are sort of sketching out different visions of what a high penetration of energy storage future would look like, and those different versions of the world vary on a couple of different axes, so to speak.

Now, the Committee met in person after the last two EAC Meetings and in those we sort of -- in those and then in subsequent meetings via phone, we fleshed out and sketched out sort of what these axes that would differentiate these future versions of the world where -- and what we've settled on at this point is that one axes is the extent to which adoption of energy storage is market driven versus policy driven, and the other axis is the extent to which the operation, use, planning of energy storages very tightly coupled

with what system operators utility and so on and so forth are doing, versus a very sort of loosely-coupled, people just buy their devices and operate them however they want.

Now this is sort of what the working group has identified right now, so I don't know that it's necessarily set in stone. Chris is leading the effort, so I won't speak for him, that that's set in stone, so given that we have these two axes, and sort of these two extremes we have at this point identified sort of four different visions of what that high penetration of energy storage future looks like.

And so we are now at the stage that members of the working group have sort of been identified to sketch out or draft what those futures look like. And the working group actually has another in-person meeting today at 1:00, just across the street, so I guess we'll find out then what the status of drafting those are, and then sort of what the next steps are.

The other work product that we are

working on is -- All right, so the other work product that we are working on, is the Biennial Storage Program Assessment. So, a lot of this material is just repeated from the update that I gave at the March meeting but some of it has been updated based on what's happened over the past three months. So just as a matter of background, the legislation that established this Committee has two statutory requirements in relation to what this Committee does in relation to energy storage.

So, one, is that every five years the Committee, in conjunction with the Secretary, shall develop a five-year plan for domestic energy storage industry for electric drive vehicle stationary applications, and electricity transmission and distribution, so that's what are termed the five-year requirement. And then every two years the Subcommittee is supposed to assess the performance of the Department in meeting the goals established as part of the five-year requirement. And then make specific recommendations to the Secretary on programs or

activities that should be established or terminated to meet these goals.

So, just to sort of lay out the framework for what we are doing now. In 2014, we had approved the 2012 storage report, and this fulfilled both of the requirements, and then in 2014, later in 2014 I should say, another storage plan assessment was approved which fulfilled the second requirements. And the reason I'm bringing this is up, is because five not being divisible by two, we run into these problems where every so often you need to produce, according to the statutory requirement, three of these reports three years in a row.

And so we are hitting that point again in which in 2016 we have a two-year requirement, in 2017 a five-year requirement, and then again in 2018 another two-year requirement. So what we are aiming to do with the 2016 product is to fulfill both of the requirements, I use the word aim there, because we are only going to do that if the work product is not going to be unduly delayed.

The reason for this is, I'll get to in a moment, is one of the things we've been done as part of this assessment is we've been conducting interviews with representatives of different organizations working in the energy storage world, and to be frank, you know, their comments that we've gotten in these interviews are at some point are going to go -- at some point, and I'd say at some point quickly, are going to go stale if we wait too long to produce this document.

And so given the time sensitivity I don't want to end up in a situation where we are approving an assessment two years after these interviews have been done, and so if we are not able to -- if we are not able to sort of meet both the statutory requirements relatively quickly than the 2016 product, the idea was that it will just fulfill the second requirement and then we'll come back to the first requirement with the separate report next year; of course trying to avoid that to reduce the amount of paper getting shuffled back and forth.

So, a few changes in terms of what we are doing with this year's assessment compared to the 2015 assessment, one is that I am aiming to keep this much simpler, much shorter than what we produced in 2014. The 2014 document, I'd say about half of it went into basically, recapping what DOE's storage goals are, what its strategy is, and so on and so forth, and I'd rather work under the assumption that DOE knows what it's doing currently, and there is no need to repeat that to it.

There was also, I'd say, a bit of an organization problem with the 2014 report, in that the 2014 assessment had recommendations that were sort of buried and scattered amongst 30, 40 pages, and so if you read it in detail, you found everything there but if you just tried to glance at it, it was sort of hard to glean what the recommendations and assessments, and so on and so forth were. So the idea now is to basically have a one or two-page executive summary of however many bullet points, with all of our

recommendations, all of our assessments, you know, we think you should this, we think you shouldn't do that, whatever and what not.

And then only if needed, basically have follow up text after the bullet points to sort of provide further context into why we are making such a recommendation, or why the assessment says this or that or whatever and what not. And again, in terms of keeping it simple in the organization, it might help us that if we can induce -- if we can say something in four pages of text, let's say that four pages of text, as opposed to 40 pages of text.

The third change which I mentioned a moment ago, is that we've been doing outside interviews, and the idea here is, as opposed to just the -- you know, five or six members of the working group offering their opinions on DOE's storage program, let's go and talk to other people in different spheres that are involved in the energy storage world, so to speak, and get their opinions on what DOE is doing well, and ideas of

recommendations for things to place on DOE's radar.

In terms of the groups of interviewees, so this sort of gives you the range of organizations that we've been speaking to. So, regulators, these are mostly regulators at the state level, ISOs, RTOs, storage developer, storage deployer, storage researchers, buried in storage in deployer so there are obviously utilities as well, but these are not all necessarily utilities that are deploying storage, but they could be other orgs that are doing that as well.

And at this point the last four of those groups we have conducted our interviews with, specific people that we've identified, and we are trying to wrap up and hand down a few regulators from a few states. And again, the idea here is to get a mixture of states that are sort of, I'd say, at the forefront of pushing storage technologies and others that are not, again, to get a variety of views on what DOE is doing in this area.

At a high level, in terms of our plan here, so by conscripted volunteers for the working group, and I apologize to them, but I don't remember who all I volunteered. So, those of you who have volunteered, thank you. We've prepared our proposed list of interviewees, alternates sort of substandard questions to ask different groups of interviewees, scheduling and conducting interviews is what we are doing right now, and we are at the tail end of having that wrapped up.

Once that is done, the plaintiffs have a discussion amongst the working group members get input from other members of the Subcommittee, and so the draft, our first cut and our assessment recommendations and goals. Then probably after that we will get some feedback from DOE personnel just to, you know, make sure that we are not missing anything in terms of putting our assessment together. And then the last two steps will be to draft and revise the report, and then submit the report for Subcommittee and EAC approval.

We are being ambitious here and aiming for getting this out by the September meeting, but that's a lot of items on the bullet list that remains to be done in the three months, but there's nothing wrong giving students an assignment that they don't have enough time to do, so --

(Laughter) So, with that I'll take any questions, comments, and of course agreement is most welcome.

CHAIRMAN COWART: Questions or comments? Carl?

MR. ZICHELLA: Yes. I just wanted to say, this has really been a great effort, and the work that you've been doing on this has been terrific. I think having participated in some of the interviews, in fact, that I think that's how we met Curt, who was with us yesterday, at least how I met him, was through those interviews, and became so impressed with what we were -- the feedback we were getting, very optimistic.

We are going to have a very useful

product for the Department when we are done. And I think whoever's idea it was to do these outside interviews it was a very good insight, because we are fielding people are actually using the work that DOE has engaged in, their impressions of it, I think are going to be very valuable, so I just wanted to say, it's been a good project, it's been fun to work on.

MR. SIOSHANSI: Yes. I appreciate that, and I didn't stress that enough. The interviews have actually been very informative for -- personally, and I think Carl or Tim, you've also -- Tim has also been on some of them, I remember and hopefully he has the same positive opinion of the interviews.

MR. MOUNT. Yes.

MS. HOFFMAN: I guess the only thing that I would add is -- or encourage is, I think simpler is better. I don't think we need, and there is no requirement for 40- 50-page report from this Committee and, you know, take your top priorities, and I think that would be well

received. For all the reports and all the activities that the Committees are working on, you know, just the comment that we're coming into this transition period, and so whatever report we get done, before the end of December, you know, we'll have that anchor point, otherwise, you might want to see what the landscape is before, you know, thinking about that.

MS. TIERNEY: That is a really scary thought.

CHAIRMAN COWART: Ramteen, are you in need of any other assistance from the Committee, or any other members of the Committee? Or do you think this seems to be going quite well?

MR. SIOSHANSI: In my opinion is it's going well. So I think, I think we have a good process in place, and it's moving along well. As I said, there's a lot to be done in the next three months, but despite my flippant remark, I actually think it is doable to get this -- to get a nice product together in time for the September meeting. So, I'm going at it with that goal in

mind.

CHAIRMAN COWART: Well, along with the others, I think it's a great idea to replace the business of telling the Department what it's actually doing, which it knows, with effort on the interviews, to collect information from the larger community that can then be assessed by this Committee and report it. That seems to me to be a terrific improvement; and congratulations, to you all for figuring that out.

MS. TIERNEY: And when you present this in September, it might be really interesting for us, including us, the DOE, who is at the meeting, to hear some of the color around the insights that you are picking up from the interviews. I can imagine that will take time to write things up about that and maybe that's a way that you could have a lighter burden on you guys, is just by talking to us about some of those insights, that would be helpful.

MR. SIOSHANSI: Yes. Definitely.

CHAIRMAN COWART: Anything further, on

storage? All right, thank you very much. We are happily ahead of schedule, and so, I'd asked if Anjan would be prepared to advance the discussion of Grid Modernization and said he is, so why don't we take that now.

MR. BOSE: Okay. So, obviously the Subcommittee, they are doing an extraordinary job, they are only taking half their time for presenting their work. Anyway this -- my report is on the Grid Modernization Initiative Working Group, and I think there's a lot of confusion as to what a working group is. I think we are the only one, as opposed as to the Subcommittees and so -- Let me just bring you up to date, as to how we came about.

You may remember about three meetings ago, when Bill Parks and Kevin Lynn presented the Grid Modernization Initiative Plan, the five-year -- the multi-year plan as it was called at that time, about the Grid Modernization Initiative, it was a cross, DOE across all departments of DOE. And the idea was to engage pretty much this

interdisciplinary area of grid modernization. And so at the end of their presentation, they asked for guidance and help from the EAC and that prompted the creation of this working group. And since that time of course, while the working group has been trying to ponder as to how we can advise and help, things have moved on, and there was a RFP and FOE, I think is the right word, acronym, that was sent out for all the labs to participate in this effort, and that process is now complete and there's a very large number of projects that have been funded, all with the national labs.

So, while the working group is kind of grappling with all of these things that are happening, one of the issues that we keep running up against, about the grid modernization is that we always start saying, this is really complicated, and even though we seem to understand what it is, nobody else seems to understand what it is. And so -- and we can't seem to figure out how to put these in terms that other people can understand. So that's kind of puts it at a

disadvantage, I think, in the communications department.

But here is what we finally came up saying there are about three areas where I think this group can help, and one is to look at the portfolio of projects that are being funded, and try to do, whether -- a check on whether this is a complete set or there are gaps. What are the gaps? Are they on target? Are they subjects, or the amount of money that are being spent on these subjects, are they at the proper priority levels, and so on? So that's one area, I think, where we would like to delve into.

The next area was this nexus of policy versus the technical, most of the projects that have been -- that are out there, that have been funded, are mostly technical, and so there is this issue of policy, because many of the -- many of the things that are being developed, come up against the policy issues, okay, so for example, in the planning area, if we are going to do certain things, certain things are being prodded

because of RPS and other issues, which are more on the policy side.

So, that makes it -- And there is an effort within DOE, especially in the second phase of the QER, looking at many of these policy issues, and so we need to be -- need to have that connection. And finally the third thing we thought would be important to look at, is what would these projects -- How will these projects be considered successful or not? What are going to be the deliverables out of these projects? Are they going to be more than just reports on the shelves, or are they going to be pieces of software processes that can be adopted by NERC or somebody else, or what -- whatever.

So those are the three areas that we thought we will kind of tackle, but as you can see these are not necessarily very well defined. So we are still struggling with exactly how to go about doing that. But one of the places we decided that we are going to start, is to look at the portfolio, and the portfolio, by the way, of

these projects that the labs are doing is large. I think it's, I don't know, several dozen projects, and I think more than a couple of hundred million dollars over the next three years.

And we didn't think we could add too much, because each of these projects have their own set of advisors, from the industry and so on, and they are delving into the details of this project. So we thought we should be staying more at the strategic level in terms of advice. And when we look at the projects, there are six projects, which are called foundational projects, and these are the very broad projects.

For example, one is to look at the development of testing networks. Another one is to look at the architecture of the power grid and the communication and the whole it. Okay. So, these are very large conceptual type projects, and we thought we would start with those as being more areas that this group can -- could probably contribute something to.

So we thought what we are going to do,

and having kind of spent, like I said, the last nine months or so, just essentially trying to decide what we are going to do. We have decided that we will have the PIs of the six projects do webinars for us, for the working group and kind of describe at a high-level what their plans are. And we actually got started yesterday, in our meeting this morning with, one of those projects, the testing networks project, the two CO-PIs from Sandia, and Idaho National Lab, come and present what they planning. So, we got that started. So, hopefully by the time we next time you'll hear more of that.

Now, Paul Centolella, who has left, he was at the meeting yesterday, and he suggested that the Smart Grid Group will -- may have some interest in this, and especially on the architecture one, and another one of those projects which was on metrics. And so we will probably do these jointly, with the Smart Grid Subcommittee. By the way, when we look at overlaps, actually, whatever the Grid

Modernization Initiative Working Group has doing, overlaps with all the sub-committees, so there is no way to get around that because it is one of these overarching, interdisciplinary things, so we can't avoid overlaps, but we are very much would like to work with everybody, and we'll try make sure we advertise our webinars widely enough for the whole EAC, so anybody who wants to join happy to join. So, that's what I have to report.

CHAIRMAN COWART: Pat.

MS. HOFFMAN: Anjan, I thank you for doing this, I mean one of the goals that I really agree with you and hope we can get out of this, is, where are the gaps, and our research portfolio in which we'll be looking at investing in. Also, I'd like to think about reasonableness, and I'm not sure how to say this correctly, so I'll just say it. It's as we are looking at doing things at scale, what does it mean for the transformation of the grid?

You can take the modeling work that we did, you know, what is the consistency that needs

to be across the industry to make a difference? You can take the sensor work. I mean, the one thing of why I had liked to place the measurement in it so much, was it gave visibility, but it gave a platform across the whole system at scale, that folks can correlate around, and really get more value out of. And so that's something to think about is, we have a lot of individual projects, but where we have a hard time is: How do we network the system?

You could take, you know, some of the projects that people are looking at, a power flow control. You know, what would be reasonable in looking at this at scale. You know, what -- you know, we don't need to do everything everywhere. You know, what is the gap? If those -- if you could think about those two ways, that you are looking at, I would appreciate that.

MR. BOSE: Yes. And you know, this is precisely what the group has struggled with in the sense that -- I think the GMI Group -- the DOE group that are doing this, are quite aware that

some of the proof of the pudding is going to be in some of the demo projects that are still to come, right, and being defined. The question is, you know, there is the demo project which says, let's put our storage over here and see if it works. But that's not the intent, the intent is how does it benefit the whole system, and that's what we are struggling in terms to get together, and I think the DOE Committee is also struggling with that.

And so I think if we can make some attempts for advice in how to choose such demo projects, and things like that, I think we will -- that needs some help, yeah.

CHAIRMAN COWART: Anybody else? Wanda and then Carl?

MS. REDER: Yes. This is more based on -- I went to one of the regional breakout meetings where there was efforts to get input, and I do think there's opportunity on the seams, because in the discussions at the breakouts, you could kind of see, where there will be a little opportunity

to coordinate. But beyond that, you mentioned that none of the advisory effort kind of sees these three pieces with the last one being output. Great idea.

I would say, in hindsight, on the ARA work, one of the things that we found late in the process was the need to get the information out into the industry, overall and that's probably something that could be contemplated at this point is, you know, demonstration, the work great, output great, but once we have it in hand, even though there's people from industry involved in that specific project, if we can contemplate the outreach mechanism in order to get it embedded into industry now, I think it would be a great advisory piece to kind of take on, and encourage that thinking early when the scoping is occurring as compared to trying to bolt it on after the fact.

MR. BOSE: I think at least the big projects, the foundational projects are already kind of facing that. They are saying, well, okay,

so we are going to have a library of software or some testing, or somebody knows about it, right. So I think there -- but I think you are right, we should probably try to come up with a communication plan of some kind and how people would know.

MS. REDER: Right. Yes.

CHAIRMAN COWART: Carl?

MR. ZICHELLA: Yes. Thanks. This may be so obvious it doesn't need saying, but and I understand some of this hard to define and remains a little vague, when you talk about modernization it seems like we have a concept of where we need to end up. I do think that need -- and that's always a moving target too, because things change constantly, and alter where you need to go. But I think at least for helping to organize our advice, it would be useful for us to have some common understanding of what it is we are aiming at, and helps us prioritize among the wired six foundational projects, foundational.

What makes them the most important? To

help us prioritize those things, and even among those things about what's most important to initiate first given where we want to end up, because the other things that we need to do rely upon those things happening, that kind of thing. I have a hard time conceptualizing how we evaluate all of this, when there's so much happening, and it's all good and it wouldn't be initiated if it weren't important, at how we actually put our finger on what are the most important things for the Department to really train its resources on; just an observation.

MR. BOSE: I think you put your finger on the top -- on the hard topic. In our conversations we keep talking about, yes, there's transformation going to take place, but we don't know where that's going to end up, and if we know I think our world would be a lot simpler, but we don't. And the question is, how to get ready for those transformations when they come along, and how flexible does the grid have to be, and how reliable, and how resilient, and how do you build

all of this into it. And I think we have struggled with the same questions. I'm not sure there's a very easy answer to that.

MR. ZICHELLA: No. I understand. That's why I think Merwin initiated the scenario planning effort for the storage work is because it is hard to put your finger on that, because things could go in many different directions, and there are different drivers, the axes that were mentioned earlier. You know, it's a nice tool for that, but it's a lot of work as we've seen and actually engaging in that, and trying to understand what those futures might look like.

Then you can track those things. You can actually look what -- for early indicators of which of those futures is actually unfolding, and it helps you guide your work as things actually are occurring, you can -- the reality test, as you have more experience based on what you had had suppose might occur. This is a tough one. It really is.

CHAIRMAN COWART: Phyllis?

MS. CURRIE: One of the things that was discussed in our Working Group meeting was, whatever we determined is needed to modernize the grid, ultimately requires capital investment by somebody. And in order to have a receptive audience for that investment there needs to be ongoing communication with public utility commissioners, legislators, and others, who would ultimately have to authorize the expenditure of the funds. And, you know, there was discretion about the role that DOE could play in terms of that kind of communication because DOE's role is not that of a utility or a vendor, or a particular advocacy group, but more of a neutral.

So, we think that there needs to be more discussion along the lines of where DOE could have that role supported through the budget process and funding that they need in order to carry that out. So that was just something that we talked about a lot.

MR. BOSE: Yes. In fact, in the grid modernization initiative, there's a whole section

on institutional issues, and where -- help and so on, but I think Phyllis is raising the issue of the communication itself; how to get people onboard that understand some of these issues, even though they are complicated technically.

MS. TIERNEY: You and Granger, and I, are on this Resiliency Committee, somewhere else, and how much of what Phyllis is suggesting, in terms of the interest of audience, really could go to the resiliency narrative, it's truly a question about whether or not there is a significant plank of grid mod that addresses that issue. And if so, then maybe some stitching of -- looking at it from that point of view could also be helpful.

MR. BOSE: Yes. What Sue is referring to --

MR. MORGAN: That's an offline conversation, Sue.

MR. BOSE: Yes. But Sue is referring to a national Committee that Granger is chairing, and it was also instigated by DOE about how to -- what are the ingredients of a resilient grid, a more

resilient grid. You know, when I think of that, I think the work that we have taken on, the Grid Modernization Initiative, is much broader than just resiliency. And so what makes our work difficult is that we have to now translate that into a portfolio of projects whose outcome is going to help do this transformation of the grid, and I think -- So to give advice on exactly what needs to be the ingredients of these projects are difficult.

So, I mean, apart from the fact that what Phyllis mentioned that much of -- that the transformation will take hundreds of billions of dollars, according to EPRI reports and other reports, but even the R&D is going to take a long time and a lot of money, more money than what DOE has at this time. And I think that -- the question is, how do we help the process that DOE gets more money, convinces the general public and the Congress that this is an important issue? And without that kind of R&D we are not going to be able to even demonstrate some of the benefits of

what's coming. And I think that's what we are struggling with, the nitty-gritty, so to speak, of this process.

MS. TIERNEY: Just as a follow up, Billy Ball doesn't realize that -- Remember that National Academy Committee which was right after, I guess, Katrina and Rita -- I don't know -- and you talked about how you were able to address AMI issues, advanced metering in order to get visibility into the grid, for resiliency after that, and that really stuck with me as an important foundational issue for all of this, and I realize it's way broader than that, totally. So, Billy, I've never forgotten that; you know that.

MR. BALL: That was a long time ago.

MS. TIERNEY: As we get older we remember things from way back, not from yesterday.

CHAIRMAN COWART: By the way, Anjan, let me just emphasize that Pat Hoffman said a minute ago, which is that I do think that it's one of the things you should keep your eyes -- that this

Working Group is looking at, this broad range of things, but to keep your eyes open to identify gaps where the Department isn't addressing something. It seems to me to be really valuable addition that can come from this group of people looking over all six of those elements. All right, thank you very much.

We have one other Working Group that the Committee has spun out, and I'd like to ask Carl, just to give us a quick update on the Clean Power Plan Working Group.

MR. ZICHELLA: Thanks, Rich. I'll just do it from here if you don't mind.

CHAIRMAN COWART: Yes, please.

MR. ZICHELLA: There is not a lot to report, we've sort of -- as the rule itself has been stalled. You know, we've been trying to suss out a little bit of where to focus our attention. There's been a lot of work turned towards modeling needs, both at the Department, here, various other agencies, and privately, private institutions that have been working on tools for states to use.

We've decided to try to come up with a series of webinars working with the Department on what the status of some of these things are, so we could get a better understanding, again, not to tell the Department what it already knows, but to try to see where we can focus recommendations for moving forward in this very uncertain period between when the Supreme Court has issued its stay and when we'll know whether or not the rule actually proceeds.

There is so much activity already occurring, the rules having a major effect even though it's not actually being implemented at the moment. We are seeing many states, if not all states, many of them, even some of them that have brought suits continuing to plan for compliance with the rule. So there is a lot happening, but we want to try to get a better understanding about the interactions between the Department and the other Federal players, EPA, FERC, some of the standard initiatives that are out there.

Caitlin has offered a list of potential

topics for us, and the next few weeks will be sort of winnowing those down, and we'll begin scheduling some of those webinars. It doesn't seem like we are going to have a rule prior to our September meeting, so we wanted to take the time, to sort of think through a little bit more about what is truly needed. I think we've heard from some of the states that modeling, in particular, and consistent modeling tools that states can use for compliance planning would be a very useful thing.

So that's one of the places, we are beginning to start and realize there is a lot of activity in that space. It's not like -- it's just getting off the ground. That's pretty much all I have, Rich.

CHAIRMAN COWART: Anything for that? Granger?

MR. MORGAN: You know, just an interesting insight that we recently got. We were in -- I'm Co-Director of a large NSF supported center, on climate and energy decision-making at

Carnegie Melon, and we ran workshop in Washington a couple of months ago, on missed opportunities and potential dead ends, with respect to climate policy.

The folks from RFF at that meeting, argued that they didn't think that the Clean Power Plan was actually going to result in significantly greater reductions in CO2 emissions than would have happened anyway, but that they thought it was really important in terms of getting various folks, like PUCs, Commissions, and state DEPs to talking to each other, who had not been doing so in the past. And so that might be a dimension that you guys should follow up on, and I would guess that -- I mean, I could point you to the right people at RFF if you need help.

MR. ZICHELLA: Yes. I'd like to talk with you some more about that. You know, it's pretty hard to put your finger on what business as usual reductions would, when in face --

MR. MORGAN: You bet, given what's happening to gas and other stuff.

MR. ZICHELLA: Yes. Not only that, but I think just the portent of having the rule, has caused an effect, people have been planning -- utilities have been planning for a carbon price for years, and actually factoring that into their procurement decisions, and we don't have a carbon price. So, you know, is the fact that we've had the conversation --

MR. MORGAN: Well, we have it in some parts of the country.

MR. ZICHELLA: Well that's true, but I mean, talking about a national one. The idea that these things are having an effect kind of skews what the business as usual result would have been even though they are not actually being implemented. It's pretty interesting.

CHAIRMAN COWART: It's the shadow of a shadow price.

(Laughter) Chris Shelton, I see you have made it. Congratulations! I have a question for you. Are your panelists here, and if we took our

break early would you all be ready to go early?

MR. SHELTON: I believe so, unless somebody wants to correct me. Yes, everybody is here.

CHAIRMAN COWART: All right. If everybody is here and we are at -- We again, have the good fortune to be ahead of schedule, and what I'd like to do is take our 20-minute break right now, and resume at 10:00 o'clock with the panel.

(Recess)

CHAIRMAN COWART: Thanks everybody we are ready to proceed. Chris?

MR. SHELTON: Are we ready?

CHAIRMAN COWART: Yes.

MR. SHELTON: Okay. Great. Well, good morning. We are excited to have a panel here that I believe I remember specifically Pat asking that it would be good to hear about the view from the trenches on energy storage, so we decided to put together a panel on that. So the focus here is trying to get a broad view of real world issues

that are happening where storage is being deployed today, or where it's being anticipated to be deployed. And we want to have as broad a perspective as possible so we want to look not only from a technology perspective, or standards but also markets policy regulation, any other issues that we are seeing out there. So that's the purpose of the panel, and we've been looking forward to it.

And we have with us today, Ellen Anderson, she's the Executive Director of the University of Minnesota, Energy Transition Lab; and we also have Mike Toomey from -- he's the Project Director for Energy Storage, at NextEra Energy Resources; we have Praveen Kathpal, Vice President of AES Energy Storage; and we have Doug Davie, who is Vice President of Wellhead Electric Company.

So, I'm going allow each of them, to do an intro of what they focus on in the industry and some -- I believe some of the panels have slides, and so they'll do a short presentation about their

perspective and then we will do a Q&A, which will be the meat of the discussion, and of the panel. I will lead off with a few questions to get things going, and then we'll open it up to the EAC for open discussion with the panel as well. So let's go ahead and get stated with Ellen Anderson. And, Ellen, do you want to go ahead?

MS. ANDERSON: Hi. Ellen Anderson, and it's a pleasure to be here. I work at the University of Minnesota, and run a pretty new center called the Energy Transition Lab. I'll start with a little bit of my background, which is in public policy, not in technology. I served in our State Senate for many years. Passed our Renewable Energy Standard, Chaired our Public Utilities Commission for a short time, and advised our Governor on energy. So, state policy is really where most of my experience is. And at the university our Energy Transition Lab is not a test tube lab, it's more of a policy and innovation kind of lab -- Are we good?

And we work in partnership with a lot of

different university experts but we are very externally focused and great, collaborative projects to advance our energy transition, and work with many, many stakeholders, around the state in particular, although we are interested in broadening our network and working in the Midwest as well.

So I would say in the energy storage area, we are emerging market, but we are an emerging market with very high potential, and a lot of interest and a lot of momentum. So we are excited to participate in something like this, to be able to really reach out across the country. And to the resources at DOE to let you know what we are -- that we are very interested in this, and we want to figure out how to grow our market, because we know even though the cost-effectiveness is a bit of a challenge in our market now, with low to moderate electricity prices, we know that we have a lot of potential growth areas for storage, and we want to be ready as the market evolves, and I think it will be ready for us to

take on in a big way, and in a very short time period.

So we want to get started now. So, I'm just going to give you little bit of background about what we are doing, so that Energy Transition Lab has created an Energy Storage Alliance in Minnesota, which is basically a collaborative consisting of stakeholders from across the interested sectors, in our state, including industry, utilities, wind and solar, NGOs and state government. And we are figuring out how we can advance storage in Minnesota.

We have about 100 stakeholders who are participating, and that just tells you about the amount of momentum and interest that we have. We are technology neutral, we are interested in all kinds of storage, and we are working primarily at this point at MISO, and we aim to really engage our Public Utilities Commission and our legislature, in helping to educate and inform them about opportunity in storage and how to take advantage of those opportunities, how to

understand them and how to create the market policy and regulatory frameworks to make that work.

And so we want to do a high-level strategy workshop, with key decision-makers in our state in the near term. I'm collaborating with Janice Lin and others on that idea, and we welcome all kinds of technical assistance and we can get into that in a little more -- in a minute. And we also are working with practitioners, who are trying to figure out how to embark on storage projects. And so we can talk about that a little bit, too, as we move forward.

So, we are really the catalyst of discussion around storage in the State of Minnesota right now, and its growing fast. So, just a snapshot of our state and region, which I'm sure many of you already know. We are in the MISO region, we are in the Midwest, we have a wealth of renewable energy resources in our state. Our state has no fossil fuels, but of course some of our neighbors, like North Dakota have a great deal

of fossil resources. So we have a lot of diversity in MISO, in our region, primarily coal traditionally, but it's shifting quickly, and a renewable component of our energy mix is evolving very, very quickly.

And so now -- that should be 15,000 megawatts of wind capacity now in MISO, it's around 10 percent wind now, but they have, double that amount in the queue, and so we expect a lot of growth in renewables, in our state in particular, we have strong renewable energy, energy efficiency and greenhouse gas rules in law and goals in law. And so, one of the things about storage that excites some of our policymakers and state government leaders; is the idea that we could figure out how to integrate higher penetrations of renewables.

If we really -- If we figure out how to do storage right, it could help enable, I think, broader support for advancement of renewables. We have a lot of wind resources, and we also are growing solar quickly in Minnesota and as you can

see we have projections, depending on who you believe, anywhere from 10 to 30 times growth in our solar deployment just in this coming calendar year, with community solar and with the solar standard.

So we are mostly a vertically-integrated regulated utilities, as I said, MISO is going through a lot of change, and it's -- a lot of coal retirements are happening, and so there could be capacity challenges in the near term. And we also have a lot of coops and municipals in our part of the country. So I'm the voice from the Heartland here. So some of the things that we've communicated with MISO or some of the market rules that we would like to see in our region, that make it more difficult to really participate in the wholesale markets and to monetize storage benefits.

You can see these; I'll just say quickly, aggregation, that's very difficult to aggregate storage resources, and other DER resources. The minimum megawatt threshold for

participation is quite high at 5 megawatts. We'd like to enable storage assets to provide multiple different kinds of value streams, and multiple functions, and not be tied to one particular asset class, because that limits the value that you can get out of different kinds of energy storage. We want to encourage more fast-ramping resources, and develop simplified interconnection.

And then, so the last thing I'll do in my quick introduction; is talk about some of the things where we hope to get, and could really benefit from expertise of a lot of the people in this room, as well as at the national level from our federal partners at DOE. We really need help in figuring out how to value energy storage effectively. We need technical assistance to do that well, and to do it in a way that provides trusted and neutral, expertise, to help to educate and inform policymakers and regulators, and energy offices at our state, and in other states about how storage can really benefit the grid.

Whether it's the existing resources on

the grid, or the new future DERs, and renewables, and other changes we would like to see in our fast-changing electricity system. We need real cost-benefit analyses that help our decision-makers figure out how to get beyond a very narrow view of, here's the upfront cost compared to the -- you know, the least cost alternative. We need to have more nuanced and in-depth analyses of what the overall values and benefits could be for storage, in order to have them face a level playing field and be able to be potentially used as an alternative.

And modeling alternatives is another piece of that, so our Public Utilities Commission is just embarking on studying, distribution planning, in addition to our IRP process that we've had for a long time, and we need assistance in modeling. I think there's a lot of participants at the state level that don't really have access to modeling expertise, and I've had some of stakeholders who are utilities, asking for assistance in modeling. Being able to really

model what some different approaches are to resource decisions and planning.

Again, expert information -- I'm starting to sound like a broken record, so lots of -- We need technical assistance ideas for a grid design, distribution planning, et cetera, and funding. And because we are in a kind of an emerging market and we have those modern electricity prices, we have a lot of opportunities to deploy storage, we have some near-term used cases, that are really positive cash flow, but a lot of them really need some funding to support to demonstrate some of the used cases that are possible. And so we are hoping that there are opportunities there at the federal level. So, I'll stop there, and look forward to a good conversation.

CHAIRMAN COWART: Great. So, Mike, do you want to go ahead?

MR. TOOMEY: Thank you very much for the opportunity to be here and speak. Michael Toomey with NextEra Energy Resources; we are a daughter

company of NextEra Energy based in Juno Beach, Florida. We have a sister company, Florida Power & Light. This is where NextEra Energy Resources operate. You can see we have a very good halo avoiding the State of Florida, so that we don't have any improprieties with trading with our sister company.

We are an IPP with over with over 21 gigawatts of energy, about 75 percent of that is renewable. We are far in a way the largest wind developer, owner and operator in the United States. We have over 12,000 megawatts in operation. This changes daily but I believe we are also the largest solar, owner, operator in the U.S. as well with a little over 2,000 megawatts.

The reason this is important, and the reason I show this map is that we are operating n a majority of the market across the United States. We have a team that's now dedicated to developing energy storage projects and we have a fairly good understanding both of the market as well as the relationships that are required to participate in

these markets functionally, and working hand-in-hand with the utilities in those areas.

We have 50 megawatts installed right now in PJM, they are all performing in frequency regulation, as well as 44 megawatts of contracted assets in California, Arizona, and the IESO in Ontario, Canada, that's 44 accumulative. Our team is focusing both in-front-of-the-meter applications as well as behind-the-meter, so if there are any questions on that, I will try to address them. I primarily focus on in front of the meter, what we call utility scale applications but I can address a lot of the behind-the-meter questions, hopefully.

Discussing what's going well right now in the energy storage market from the viewpoint of the developer, or from myself, Praveen can speak to it as well. First, or PJM did a phenomenal job rolling out our market where energy storage could be utilized and can be fairly compensated and also rolled out immediately. Like I said, we have 50 megawatts in PJM, operating as of today.

Absolutely performing well, and earning a solid revenue.

However, it is important to note that this is a merchant revenue stream, so it will be difficult to finance in the future. Next is California, they kind of came at it from a different approach. There's a state mandate in California for 1.3 gigawatts of energy storage by 2024 I believe it is. So what they did, as opposed to PJM, saying we want frequency regulation and batteries kind of fill in that role, California took a reverse approach saying, we need to procure batteries, what roles can we apply them to? And with the shutdown of SONGS, in Southern California there was a huge need for capacity, and that's been a major driver for procurement currently in California.

SCE, SDGE, and you are looking at primarily capacity application for energy storage, that is defined in California as being a four-hour system, so that's what you see in a lot of contract to day. Unfortunately -- well

fortunately for the buyer, unfortunately for the market, everyone is expecting a very similar cost decline as was seen in the solar market a few years ago. So a lot of the contracts that are being awarded today, are for projects expected to be built a few years out.

So you are not seeing a lot of the development today. One of the areas where that would not necessarily hold true is in behind-the-meter applications in Southern California, in New York, if rates are high, if demand changes are high, you will see energy storage deployed behind the meter. Some of those contracts can work well where you have a dual role for behind-the-meter projects, performing demand change management for the customer, as well as demand-response type application with the utilities; so there are some dual use in that sense.

In terms of what needs to be addressed, I think it was discussed quite a bit yesterday, I think everyone on the panel will agree today, and

you will hear it quite a bit. The understanding of the market values of energy storage are very important, currently there is only use cases being contracted with utility. Demand charge management for behind-the-meter applications, is a second used case for energy storage, however, that's essentially a contract with the end customer, not with the utility, so you are only seeing individual applications being used by utilities.

I think that a lot of the help that will be beneficial to the utilities would be understanding, or more clearly defining when they need certain applications, a battery that can perform capacity in the afternoon, can absolutely perform frequency regulation in the morning if that's what beneficial to the grid. However, right now the contracts are very limited to performing one function, that's been helpful in getting some of the rollout, but it's also stalling some of the understanding.

I know a lot of the times that I meet with utilities, we come in and we show a host of

applications that a battery can perform, it kind of sounds like a silver bullet for all of the problems. And as the conversation continues, you start backing away from application and application, till there's just one, that's much easier to wrap your head around. Okay, I understand that, that's where I'll deploy for now, we'll worry about the rest later. So, having an understanding of where we can have dual use, triple use, and more, will be very beneficial.

Also important to note is that energy storage is in this grey area, between participating in markets and being a transmission service provider. There are many benefits to the -- for T&D deferral, for example, that energy storage can perform in, and that's not a market. Right now that is service provided by the utilities, there are specific requirements on returns, and all of that involved with it, it's now something that be played in, and that again, as a dual use, a very wonderful benefit of energy storage is the transmission services that

provides, that is hard to quantify right now, in terms of benefit, in terms of procurement.

So if a utility is looking to procure energy storage, if they have a mandate, for example, if you put it in a load pocket versus outside of the load pocket, in your generation and something like that. You are not necessarily quantifying and valuing the transmission benefits that this system is providing by positioning in a load pocket.

Also there are avoided costs with energy storage systems. It can provide tremendous benefits, especially right now in California, we are looking at 50 percent renewables by 2030, and most likely that will come earlier than expected. What you are seeing though, especially with as much solar as coming on in the system. There will be economic curtailment of solar generation.

And what that means, as we continue to grow towards 40 percent, is that you'll have to add additional megawatts of solar to reach that 40 percent because of all the curtailments that are

happening during peak hours. Energy storage can make the deployment of other resources more efficient when you are including renewable energy.

The other side of it -- These are benefits, everything I discuss that applies both in front of the meter and behind the meter. The other set of issues are primarily for in-front-of-the-meter applications, which is with respect to siting projects. I've mentioned already that there are some benefits to -- or economic benefits to siting projects near load, but there are, right now, technical issues preventing such deployment, when transmission operators are evaluating any generation asset, they look at the worse-case scenario to assess what upgrades are needed to be performed on the grid for that project to succeed.

Unfortunately, for energy storage it is both load and generation, and it is penalized in whichever way is most disadvantageous first location. If a project is sited near load, it is looked at as a load resource during those peak

hours, because that is obviously the worse-case scenario. Even though with market factors, that would not be the way an energy storage system would operate.

Similarly if you put it near generation, you would be charging ideally let's say in the Mojave Desert where there's plenty of solar generation, and probably up to 1,000 megawatts of economic curtailment, in the coming years. If you put storage there you can absorb that energy discharged later in the day, and provide to the grid, whereas right now, those systems would be looked at extra generation and being a further hindrance to the transmission grid. I think that that covers the issues that we see across the U.S. right now; and happy to answer questions in a while.

MR. SHELTON: Okay, thanks. Praveen?

MR. KATHPAL: Thank you. So, again, my name is Praveen Kathpal, I'm with AES Energy Storage. We are part of AES, the AES Corporation is a global power company. We have power

generation and utility assets all over the world. We operate in 17 countries, so we have experience in the U.S. and in several other markets, and we've been doing energy storage, as I'll show you, in the U.S. and abroad, but broadly our experience is with a wide range of grid technologies.

In energy storage we are a developer and a solution provider, so what I'm showing you here, is our fleet of energy storage arrays with is the largest in the world and that includes 116 megawatts in operation, 50 megawatts in construction, and 218 megawatts in late-stage development. We started with ancillary services applications in the U.S. and in Chile, we've expanded providing that product line into new geographies, so we are now doing similar applications in the Netherlands, Northern Ireland, Philippines, and a few other places.

Domestically we've expanded our offering beyond ancillary services, we are also providing capacity solutions, to utilities in the U.S., the best example of that, is a 100- megawatt project

in California, that's going to be built in Long Beach, it will serve Southern California's -- Southern California Edison's local capacity needs in the Los Angeles Basin over a 20-year contract.

So that really signifies that storage is here at scale, and also that it's a proven alternative for providing flexible capacity that compares well economically against the conventional solution which, in that case would have been to build a new gas-fired peaking plant. That really in the U.S. Is the biggest -- is going to be one of the biggest applications for storage. Some of the models that AES subscribes to, shows a 40,000-megawatt need for new capacity in the U.S. over the next decade, 40,000 megawatts.

And I think that what we'll get into in the panel conversation is the analysis that DOE can provide to utilities, regulators and other stakeholders can help illustrate that energy storage does provide more benefits than the conventional solution, not only in the capacity

arena, but also in the T&D arena. That gets to the issue, building 40,000 megawatts of peak capacity is a big problem that the industry faces.

There are a lot of big problems that the industry faces right now and -- Sorry, I'm a slide behind. This is a rendering of the 100-megawatt facility that will be built in Long Beach. So there's a lot big problems that the industry faces. I talked about building peaking plants, but here's also keeping with retirements, we see old steam turbines, we see nuclear plants retiring, we see a variety of causes whether that's one through cooling, air emissions, or just plain being old.

So there's a lot of planning issues that come up, whether that's on the generation capacity or the transmission side related to this turnover in our grid, and obviously that ties into the transmission expansion that is needing to be done to support wind and solar facilities, that at large scale, are generally built distant from load, and other rid modernization initiatives that

are occurring. As well as, of course the sometimes very acute issues that we face with our gas infrastructure, where the transmission or the storage of gas, the fact of the demand for natural gas, and the demand for electricity are coincident, creates a strain on the gas infrastructure and storage offers a -- on the electrical system offers a way to separate those.

So, there's a lot of analysis of these benefits that can be done. DOE is doing some of it, and we think there are some good frameworks out there. We've seen some examples of papers that have come out of the labs that have analyzed the benefits of storage on a system-wide basis. They've taken into account the capacity benefits, but there is not enough of it, and it's not tied in all cases to relevant big problems that the industry faces, some of which I listed on the previous slide. And we can talk more about that in the panel discussion.

MR. SHELTON: Last but not least, Doug?

MR. DAVIE: Thanks, Chris. Thank you,

to the Committee, for inviting me here today. In particular Janice and Merwin Brown, who were key in convincing me this was definitely something to come out to and talk with you folks. Let me just tell you a little bit about Wellhead, what we are doing, and kind of an overview of what we see as issues.

The biggest that I see, is that we are having a really hard time, with getting people to fully understand and appreciate the problems in deploying storage and how the rules and regulations are holding things back a little bit.

Quickly about Wellhead, independent power producer, we've been in business for over 30 years, started back in the QF era, we are California-centric. One of the few IPPs that has not gone through a bankruptcy because we did not go merge it with any of our plants, and have used capital wisely, we have about 350-375 megawatts operating in California, 50 megawatts in New York; have built projects for Public Service New Mexico, San Diego Gas Electric, that went over in Ghana,

but we've survived because of how we used technology innovation, and we deployed our capital, and we spend money where think it's the right way to go.

And the key that I'll talk about next, is we have the company, Wellhead Power shall -- and one another thing, we do have a woman-owned affiliate, that's 100 woman-owned that does the only woman-owned project in California, the Delano Energy Center, and they now have a contract that was acted on, appealed last week, the Stanton Energy Reliability Center, which will be 100 megawatt project in the Stanton area, and that project will also include storage, where we have a contract.

Real quickly, there's a lot of details here, I'm not going to go about digging into it too much, but this is an overview of our EGT technology. We have a patent pending, we have trademark on name, we are working very closely with GE, but basically we are looking at storage, in this case has an enabler, where we are going to

be able to integrate storage with existing GE LM6000 technologies, and in effect create a zero -- convert a machine that's typically 5 or 10 percent of the time for peak needs, into something that can used 100 percent of the time providing ancillary services.

Think of it as your hybrid car, when you step on the accelerator it goes, you don't if it's the battery or the gas engine that's making you go, but you know something inside is controlling it, and it's making the right decision. Our hybrid is an integrated resource in the same way. You've got GE LM6000, some battery storage, and a control system. And the key things about it are, you can have 50 megawatts of ancillary services, with zero Pmin, zero gas burn.

You've got fidelity of your operating range. You've got accurate regulation, you know, you've got frequency response, voltage response, primary frequency, the system is managed internally, it is -- the state of charge is managed internally, so we don't have to worry

about dealing with state of charge issues, with the ISOs and, you know, there is just the number of very significant benefits to it. Conversations with utilities, we've talked with PJM, Cal ISO, a lot of organizations are very interested in it, but we are running into some issues, but it's a technology where we are using storage as a huge enabler, we've been working on this for a couple of years, and want to get into a little bit of the problems.

Before I do that, real quickly, the business case for it, particularly in California, you know, there is a great pair of benefits obviously from the ancillary services, both serving entities, a key thing that is not talked about that much, that as a result of a result of storage and the capabilities it allows a reoptimization of the entire system, and the result is, you are going to be using zero GHG capability to provide certain ancillary services rather than reserving the capability of more efficient combined cycles.

So you can have a much lower -- you can reduce the overall market price and cost of producing power, and so there will be some significant benefits to consumers and load-serving entities because of market implications, with the reoptimization. That doesn't go into the direct GHG benefits, as well as another very important thing that I have a slide that will it real apparent, are the implications this will have on the operating costs to combined cycle as well as peaking plants in terms of what they have to do in terms of following loads, starting, stopping, and cycling costs.

And those are becoming more significant on peakers in California, and the owners are peakers, and the utilities were theirs, a lot of people are complaining that they are getting the devil beat out of them, because with renewable integration they are operating in a very different mode, and they are just doing a lot of cycling, which becomes costly to thermo plants.

Some key observations about where we

are; is that one, we have seen in California a denial of how significant a problem it is, and how soon it is coming. We are starting to get over that right now, but there is still an issue, of a lot of people thinking there's time to wait, but in California we have not seen it. You know, we are seeing over-generation in thousands of megawatts, it's very routine this spring, and the Cal ISO was now onboard, that we are seeing the problem several years earlier than they were previously expecting.

And I would certainly agree with what Mike said earlier, we are well on the road to being 50 percent well before 2030, in fact, we think we are going to be at 40 percent by 2020. The key problems we are seeing is dealing with the regulators and the agencies of Cal ISO utilities, one, the analytics, in terms of valuing, it's not easily done. There is, you know -- You are talking about reliability services totally tearing apart all of the kinds of services that can be done, and provided by storage, and how do you value those

separately, they aren't markets for them, so that's causing problems.

And we are way out ahead of, for example, the Cal ISO and their rules and regulations, in terms of where and how storage can participate, what services are eligible to provide. A simple example, and this goes back to a NERC regulation, is that operating reserve spinning is defined as unloaded synchronized generation. How is storage synchronized?

And so there's a question, you go to the markets and you are going to finance something. Well, is this going to be tariff compliant? Is it going to be, work with the regs? So there's paperwork to be done, and everybody agrees, well absolutely it should be, but there's still paperwork lagging because the rules and regulations were revolved around what we knew and what worked because of the importance of reliability, probably so, but innovators were ahead of them.

Another key problem, working with ISOs,

you have to go through stakeholders processes that are very long, and you typically end up with mainstream solutions that are not necessarily friendly and open ideas, and new ways of doing things, even though you can meet the performance requirements and enhance the objectives, you still have issues in terms of, did the rules work?

Interconnection, as Mike indicated, is an issue, however, we have been able to work through and found ways dealing with the utilities and with the Cal ISO, to get around most of the problems, and they understand where they are, causing those problems, and they are definitely working to help with that. I mean a real simple example that Cal ISO through their UConn was not able to detect a storage unit that was sitting was available.

It's like sitting in the driveway with your hybrid, you've hit the start button, the lights were all on, but you haven't started to move. They couldn't detect -- they didn't have a light that was on, as you have in the dashboard of

your car that says you are ready to go, that hasn't been corrected.

I do have one additional slide I do want to hit, and this gets to the comment. This has to do with something we worked on, and this is the part of what storage that gets to the valuation, what we are really trying to do in California as a result of renewable integration. And what we have here is a graph that shows, from a modeling standpoint, the difference between the day ahead forecast, of loads, and what is really happening in the five-minute loads, and so you are seeing --

MR. SHELTON: Doug, there is a laser pointer there -- if it's going to work but -- I guess not.

SPEAKER: It's the red button.

MR. SHELTON: The red button? Yes. There you go.

MR. DAVIE: So, what you are seeing is from hour to hour, you've had changes and you are moving at short distance maybe from one point here, to another point, but within that hour, you

are jumping all over the place in terms of volatility. Well, that's the load that has to be followed by some sort of a generated resource; this is volatility that's a result of renewables. It's a problem with excess of riches.

The blue is showing where there is over-generation occurring, but the purple line is showing the way you are having to follow with some sort of load-following unit, storage can do this very easily, very quickly, and dramatically reduce the wear and tear that's otherwise going to be occurring to your thermal units.

It's not something that's, you know, really valued or recognized, but it's a reality and if you talk to the owners of the gas assets, they'll say, there's a lot of proof to that. And so the storage can not only help with reduction in the amount of over-generation, but it can also have a lot of benefits and wear and tear, and the result of the EGT being part of the fleet, is that you reduce the Pmin burden on the system which has an overall reduction in over-generation during

times of peak generation of solar during the day. I'm going to stop at that point, and will let go to questions, and then go from there.

MR. SHELTON: Well, thank you, all, for the overviews, that was really helpful. We are going to go ahead and get into some questions, and some of these have been covered in different levels by each panelist, so we'll hit them, and give everybody a chance to chime in. So, I think we've highlighted, there is, that were going well. I've heard that from a few of you. So, are there any other areas that you've seen in the industry that maybe -- that didn't relate directly to the work that you all are doing? But that you are aware of, or that you didn't comment on. I just want to get a chance to focus on the positive here again. What is going well out there? Maybe, Mike, do you want to chime in on the behind the meter, perhaps?

MR. TOOMEY: I'll touch on a little bit about behind the meter, but just in general what we are seeing in California that is definitely a

positive, and Doug tapped on it a little bit, is the financeability of these projects. They are long-term contracts with the credit-worthy off-taker which makes them financeable, and allows us to continue to deploy capital and build new projects rapidly. That's something that's not necessarily the case in PJM with the frequency regulation market. They are merchant prices that you are taking on, so it's hard to finance those revenue streams.

Similarly, for behind the meter, you are contracting a portion of your system with the utility ideally, the other revenue stream is demand-charge management, which is with the customer, generally speaking, out of creditworthy off-taker or counterparty, as well as not a sustainable revenue stream. You don't have as much vision in terms of the future value of that product. Now, it is a valuable product, and that's important to note, but in terms of financing for deployment, that is a difficulty.

MR. SHELTON: Why do you think that --

What do you think led to the blossoming of the storage in PJM, as a follow up? And maybe Praveen, you have thoughts as well.

MR. KATHPAL: Sure. I think in PJM, and I think this generally applies for the organized markets, it was a clarity of needs and requirements. And that's a general principle that goes well beyond storage. Is that if the needs are defined and the requirements are defined, then storage or any other technology could come in and serve those needs. And the markets have the additional benefit of the value being illuminated --

MR. SHELTON: So the, I guess California and PJM have that in common, right? Where the market has identified needs, clearly that are technology-independent needs?

MR. KATHPAL: Right, in California, I think the reason Mike brought this up, the reason you've seen a number of contracts with storage happen, is because there is a capacity need, right. At least a couple of the utilities had a

need in Southern California to meet peak demand, but also really importantly is there was a requirement that was defined which is to serve for four hours of duration.

That certainty doesn't exist in a lot of places, it's something that certainly the regions that have capacity markets could address, and I think in one of the current proceedings at FERC we'll see a move towards that. However, they will still have the challenge that Mike just raised, of not having long-term financeable revenue streams.

The bigger issue I think that we see is those needs are really murky outside of the market areas. The requirements are really murky. There's clearly a need to provide peaking capacity. I threw out that 40,000 megawatt figure over the next decade, so there's clearly a need there, but in a lot of cases, storage hasn't been identified as the solution, and that won't really happen without a clear definition of the requirements to provide that service.

MR. SHELTON: So, Ellen, this is a

follow up, it wasn't one of the specific questions, but what specifically are you doing as part of the Minnesota energy storage work? Are you doing -- Are you learning from this, are there specific things, where are you focused on providing this clarity? Have these topics come up?

MS. ANDERSON: Sure. A lot of these topics have come up, and we are trying to put together kind of platforms of basic -- you know, sort of grounding in these -- in the key issues, what you need to know about storage in these different topic areas, when it comes to regional markets, when it comes to -- you know, participating in those, and when it comes to the state level, where does it fit? So we are trying to provide neutral information that can help decision-makers.

And we are just getting started, and we, going back to sort of the good news, is there's a huge appetite for that, and there's a huge interest and there's a huge interest in doing

projects around the state. So, for example, a lot of solar developers that have been doing solar for whether a long time or a short time, are trying to add storage into their projects, and a lot of those were behind the meter, and trying to figure out, kind of those questions, that Mike said, well, how do you play in the wholesale market if you are doing a behind-the-meter project? Can you? And how would you set that up? And it's pretty complicated for a small solar installer.

Can I mention -- I want to mention the Community Storage Initiative real briefly as well, because we were just talking about that beforehand. And we are partnering with NRECA who started this with Great River Energy, one of our G&Ts that has a bunch of co-op members in Minnesota, and they started with electric hot water heaters, and they controlled Great River Energy Controls, and I think it's 100,000 electric hot water heaters, and that's, you know, the load shifting, it's a form of storage and they are storing it as a thermal -- in a thermal form, but

they control a gigawatt of electricity that they can shift away from peak to off-peak hours.

So they are starting this community storage initiative which is very focused on kind of how to make storage accessible to the people in communities, people at municipalities, at colleges and businesses who want to be able to figure out the benefits. How does this -- How can I play in this -- How can I have a role in storage? How can I do it at a small local scale, at a community scale? And I know we have a lot of interest in that, as well as a lot of interest from utility companies who want to figure out how to do this, and want to do big projects.

One more thing that I wanted to mention, that it's sort of the policy, political side, that I think is a really interesting insight that I heard, and learned over the last year of working on this, that energy storage is kind of bipartisan. In an energy world that is anything but, there is the possibility of having a conversation across political spectrums, because

it's got that kind of gee-whiz factor that a lot of people are interested in. And you know, it doesn't mean that you are going to agree on all the policy roads to get there, but it's an entry point that allows for a really constructive conversation about the future, and how do we modernize our energy system.

MR. SHELTON: So, yes, go ahead. I was just going to come to you right away.

MR. DAVIE: I wanted to talk a little bit of the good news here, because I've talked about problems, but I do want to add, I think, some good-news perspective on it, is that one, last Thursday the California Public Utilities Commission issued a resolution directing Edison to go out and procure a significant amount of storage, as much as 600 or 700 megawatts, with the requirement that it be online by the end of the year. So, you are going to see a lot happening in California very quickly.

We are looking at, you know, definitely there's going to be hundreds of megawatts of

additional capability proposed, at a similar look at the numbers in terms of whether it helps with the Aliso Canyon problem. And so we are going to see some things there. I would say, independent of that, with one of our EGTs, and actually just the one thing I didn't mention is 10 megawatts, 5-megawatt hours, so it doesn't require the significant investment in huge capital for storage to enable a 50-megawatt project, and provide 50 megawatts of ancillary zero GHG capabilities.

So, we are going at it in a way that doesn't require, as big of initial capital expense, and we are actually, prior to the Aliso Canyon activities, we were in discussions the utility and have plans to have of our projects online before the end of the year, and that is one of the reasons why I've had a lot of down-in-the-weeds discussions with the Cal ISO and the utility problems.

But clearly they know how to value -- this utility knows how to value and say, this is something that's good, they were prepared to go

forward without an RFO, just because it was a net benefits, to the rate payers of putting this project in place. So, I think there is some good news along that line that I didn't touch on before.

MR. SHELTON: So, following this theme of providing -- of the frameworks that are working, perhaps, and maybe how to replicate those, or how to inform similar systems across the ecosystem in other states. Are there specific areas that you think DOE could be helpful in informing frameworks like the ones that -- you know, some of the things that we are learning from California, or PJM, or other states? Are there you know -- What could DOE do to make a difference there, in your view?

MR. KATHPAL: Sure, I'll start. So, I think capacity planning is a great example, and this is something that happens in a lot of states, and in all the states where the utilities have a supply obligation. Generally these are places where integrated resource planning occurs, and

these planning decisions are not taken lightly, they are often multi-stakeholder proceedings in front of the Utility Commission, they have participation from consumer advocates, from environmental groups, other NGOs, and with regulatory staff.

So, what's happening in that arena right now is incomplete. And a lot of it comes from a basic absence of the education of the stakeholders and the analysis to support the benefits of storage. A lot of stakeholders don't recognize that storage large-scale peaking solution. That the same time their utilities and their states are considering peaking plants in the 50 to 500-megawatt range, that storage can directly substitute for that in a way that will be lower cost to the customers in those states.

It will improve reliability and it will lower emissions. So what can DOE do about this? It's the analysis. The Energy Storage Association did a survey a couple years ago, of regulators and of legislators, in the states, and it was

conclusive that DOE and the national labs are a trusted, independent source of information. But that information flow isn't occurring. The type of analysis -- What am I talking about when I say, analysis, is in any of these planning scenarios, and this could be done on a regional basis, for many utilities and balancing authorities were considered, a regional analysis in which someone could run a production cost model with storage, compared to one in which a peaking plant is built.

To show the operating cost savings, that's fuel, O&M, avoided starts, lower emissions, show the capacity of benefits and compare that to building a new peaking plant. The same concept can be applied in the transmission arena, but the cost of building a new transmission line. What's important here is the focus on the benefits, because that's what shows the reduction in cost to customers that we think should be motivating policy in the states, and I focus on the benefit not cost because we've seen routinely when researchers, when labs try to publish a cost

benefit analysis, or a cost guideline, and a whitepaper or a handbook, it's completely off, versus the cost of storage on the market, often by 50 percent or more; so there are some unflattering --

MR. SHELTON: It's off in that.

MR. KATHPAL: It's high, because the information is usually flowing from dated estimates, or subsidized demonstrating projects, not real procurement data in the market. So I would advise the labs to try to stay out of the cost arena, and focus on the benefits. When procurement happens the market will show you what the costs are.

MR. SHELTON: Does anybody else have more thoughts on this?

MS. ANDERSON: Can I jump in? And just echo, yes, yes and yes. That would be so incredibly valuable. I mean we've looked at Sandia Lab's reports, and other reports, like Rocky Mountain Institute, et cetera, but the labs, talking about all the use cases for storage, it's

really useful information, but to be very honest, you know, in the Midwest if you say, well they did this in California and it worked great, it's not going to persuade a lot of decision-makers, number one, and our Commissioners, you know, they need a record that they can make decisions on.

They need information tailored to our conditions. So, we need that sort of analysis, very, very badly, but we need it to be regionally-specific, and also forward-looking. I mean, what if we increased our RES to 40 percent or 50 percent what would that look like? How would that change the factors? What if electricity prices went up this much? Or storage prices went down this much?

MR. SHELTON: So, Ellen, it sounds like you are saying, doing these regional studies, would be valuable, but it sounds like you are saying, yeah, that would be helpful, but you probably need -- Do you need tools then, that can be used? Because I don't know if DOE is going to do a study just on Minnesota, do you know what I

mean?

MS. ANDERSON: Come and do modeling for us, yes.

MR. SHELTON: So how does that translate to you? Is it tools? Is it frameworks? Are there -- I'm just trying to, you know, pull more out of this.

MS. ANDERSON: Yes. I know. I don't exactly know how to deliver them, and what DOE can deliver because, yeah, we'd love them to come do a custom project in Minnesota, and I don't know if that's going to happen. But to do some -- help us learn from the knowledge base that exists around the country about what kind of analytical tools can be applied to these questions. And also sharing -- you know, sharing of research that's already been done, because in a sort of translational, so that policymakers and regulators can really understand the knowledge that does exist, and kind of the cases that have been proven out. Because there's a lot of information out there, but it's not always presented. Just come

and talk to us, and share knowledge and information.

MR. DAVIE: And one of the things that I think is most important, is getting the actual projects on the ground, because utility operators, regulators, and politicians are, for good reason, very conservative. When the lights go out, executives get fired, politicians get recalled, and so, it's one of the reasons we have moved forward to find a way to get a project that we are talking about, in the field by the end of this year, that's been something that we've, put out as a corporate objective earlier -- at the beginning of the year.

But that's a way you are going to get out and demonstrate to the utility operators, that in CAISO that this does work. They can use it, they can rely on it, and they will start seeing the benefits themselves, and so real projects are in fact, critical, to moving forward. One of the biggest, you know, areas we run into is, wow, how do we know it's going to work. How do we know

it's going to -- What is synthetic inertia? How do we know this allows us to decommit some resources in the L.A. Basin, and still have reliability?

There's question about -- There's a show-me attitude, rightly so, and so getting real projects is critical. And once you start doing that, to Ellen's point, I think that is a utilities system operation that how electric system is operating, and how electricity flows, and resources respond, you know, they respond the same in Minnesota as they do in California, you've just got a different resource mix, that's driving that response. And so getting some real projects out is critically important, and in fact I think that's why the PUC's decision is going to very valuable and important to the storage industry because that order was procure storage resources. So, you are going to see him in the ground and operating by the end of the year.

MR. SHELTON: I'm going ask a follow up, and then I'm going to go to Mike, because Mike

has, again, something he wants to say. Does that speak to a survey of the stuff that's already out there, because there's a fair number of projects, just on the panel here, there are a lot of projects, right? And there a lot more than are represented here, would that be valuable, a survey of what's going on out there? I mean, rather than focusing forward just on demonstrations, so that's a follow up for anyone.

And then what about the EIA, is there anything that the EIA should be doing with regard to storage? I'm just following up on that line of thought.

MR. KATHPAL: Sure, so I definitely want to continue on that vein, Chris, to clarify what Doug said. I hope no one interpreted that as a need for more demonstration projects, we have to get passed this it hasn't been done here, mentality. The timeline I showed, the gap in studies that DOE has done that I think are good analysis has been replaced. That void was where a lot of demonstration projects are being done. For

a fraction of the cost of one of those demonstrations, you can get all the relevant stakeholders on a plane and take them to go see one of these things that have been running for years, and years and years.

There's hundreds of megawatts of utility scale storage, running in this country right now. So the live procurement is a way to do it, get more projects online now, taking people to these project is a way to educate them, paired with the analysis of the benefit, it's not about doing more demonstration, because what I think is an assumption a lot of us have been speaking from, that hasn't been stated here is, this is not a technology issue, it's a market adaption issue.

The technologies are mature, so picking a state and throwing $5 million at, you know, betting on whether the neighborhood startup can build a storage project in the next three years, I think actually has a counter effect of freezing action by stakeholders in that state until that task is complete. So, I would focus more on

meeting real needs and solving the big problems that we have.

MR. SHELTON: So, Mike, did you want to chime in previously? So, sorry about interrupting you --

MR. TOOMEY: No worries. Praveen just mentioned right at the end, and that's what I want to highlight, is that it's more about helping utilities understand their needs and what those costs -- what are the options for addressing those needs. That's where energy storage comes in -- as Praveen said, it's not a technology issue, we can come in and help solve whatever problem is going on in terms of energy storage, but it's about understanding what the issues, are.

For example, let's say in the middle of Arizona, they are reaching their peak capacity, they need to install a peaker. Well, if an analysis is done, that peaker might get turned on, 10 times a year for two hours. Do you need to build a huge peaker system that's only going to be performing for 20 hours a year, and producing

greenhouse gases and all that goes with that. When you could use energy storage, the same two-hour system and have it operating throughout the year, there's no additional cost to operating that throughout the year, but an important part of that is working with the reliability operators in those areas to get comfortable with that idea.

Currently it's really nice when you do have a new peak capacity to build and peaker and you are set for a very long time, and it can run for 100 hours if you needed to in some type of emergency. For reliability operator to get comfortable with, we've done the analysis, we know it only need to be turned on two hours a year, is that going to be sufficient. And there's a gap there with addressing for some of these functions, the comfort of the reliability operator, and the role of the utility, and ensuring that they do appreciate, an energy storage system will meet their needs, so that's definitely an area where the DOE can help.

MR. SHELTON: So, I have one -- I'm

actually going to jump to technology, because DOE's mission has four pillars to it, and two of them are really highly relevant to the energy storage discussion. One of them is to catalyze the energy transition, to paraphrase, and so that's what we've been talking about. It's that catalyzing role that DOE can play in moving through technology innovations, we've seen them do it with renewables. It's been incredible, the support and the outcome that we've seen.

And I think in the storage area, that a lot of people are hopeful to see the same type of catalyzing effects continue, which have already been started under the storage programs that DOE already has. So that's the discussion that we just had, so just so that you know we actually -- I'm intentionally focusing on these two pillars.

The other pillar is stated as maintaining a vibrant U.S. effort in innovation -- Maintaining a vibrant U.S. effort in science and engineering as a cornerstone of our economic prosperity, with clear leadership in strategic

areas. So I wanted to at least have the panel chime in on, what we believe in, and are focused on the panel, the idea is that the catalyzing role is critical and it needs to be enhanced, it sounds like from the discussion. What do you think about this other -- science and technology role and how it applies to storage and the promise of storage, and you all have outlined is tremendous? So clearly, more work in technology seems to be merited. So, can you each chime in? I can start with Ellen, and we just go down the line?

MS. ANDERSON: Sure. So I asked some of our research scientists that question before I came here, and said, what would you say? And they all said, well, I talked to like four of our leading researchers at the University, on storage and renewable energy, and they said, remember it's not just about electricity. So, thermal storage is important. We have a solar thermal lab that's doing a lot of innovative work. And other forms of storage besides battery.

So that was part of their message, that

there's a broad array of different technology types that are high potential, and that we don't want to just get -- narrow things down too much, and then also a request for supporting commercialization, and supporting pure research too. So, trying to help some of those lab tests when ideas get to market, and I guess the other piece that I have to say, and maybe it's not answering your question, but I have to respond a little bit to Praveen, because we, you know, we wanted to be a laboratory to try out one of the new flow battery technologies that was developed by a national lab.

I think it's similar to what Avista is doing, that we heard about yesterday. We were trying to get some funding, so that we can demonstrate that, and so I want to push back and say, in a state like ours, in a market like ours, we are not seeing a lot of activity from the bigger companies because we are not quite there yet. And so we need that -- We have that chicken and egg problem, and we need to gain experience.

Our utilities need to learn how to use these things, and how to actually operate them in conjunction with wholesale and local markets, and maintain reliability.

And Commissions need to see that before they are going to say, go ahead, and approve cost recovery. So we have some of those problems that -- otherwise we can just and wait until you come, and say, great, we are ready, we are ready, but we need to jumpstart the market by doing some local work, and it needs to be at scale. And it would be great if we can use some of those innovative new, new technologies that are being developed at the labs, and trying to demonstrate them in a place that, for example, has, you know, the micro grid that we wanted to test this on in Western Minnesota, has a mixture of bio energy, solar and wind, because we have all of those three resources kind of balanced in terms of the resource potential that we have in our neck of the woods. And we have extreme climate. And so we have some other unique characteristics that we could test

with some of this technology. So, I guess that's my message, yes.

MR. SHELTON: Thanks. Mike?

MR. TOOMEY: I'm going to bridge the gap of those two comments, and say that it is very helpful both in the advancements in the industry, as well as for the off-takers. When the needs are defined in very generic terms, not to say I want batteries in my area. It's, I want to provide capacity in my area. I want to provide frequency regulation. I want to perform some service, if those services are defined, to allow anyone to compete energy storage will come in as well, say we will meet those needs, maybe you don't -- If you have a need clearly defined, someone like Praveen can come in and say, well, I'm doing that in three other locations.

There's a little bit of trust that can be brought in with an IPP. When they come in with an energy storage solution, if it's to meet those specific needs then you can point to how you are doing it, but if it's just a goal of saying, I

want energy storage for the sake of energy storage that's where you get into this very muddy and where having test facilities is very important.

MR. SHELTON: Yes. And I think I will violate my panel, house role here, and add, if you work in the early stage, you are bound to have issues, right; and those -- you don't want those to inadvertently inform policy. You don't want a technology misstep which is normal in early stage stuff, to hurt a broader policy potential that you can have. So you want more established technologies when you are focused on policy. That's, I think, where maybe Praveen's comments were coming from; so, to try to further bridge the gap.

So, any technology areas, Mike? I mean, I know we want to move on and get to the broader EAC, to certain questions, but go ahead. Mike, no. You don't have any? Praveen?

MR. KATHPAL: I think as to the technology research agenda, what I think would be very interesting and where DOE could play a role,

is let's fast-forward 20 years, we have all these resources of today that are retired, all these renewables have been built, all the storages out there, what does that world look like, and I'm talking about down to issues of control schemes and transactions, right? How does that affect our current idea of interconnection studies, or reliability or flexibility, or even of wholesale markets? What are all those implications on the infrastructure and the institutions that we know today, of a future that we know is coming?

And then reverse that and say, okay, well, let's look at the decisions we are making today. Are they forward compatible with that future? Are we committing 20, 30-year investment to assets that will be stranded? Or, are there alternative assets and technologies we can build today that are more compatible with the future we know is coming?

MR. DAVIE: A couple of comments. One on the technology side of it, I mean, absolutely there are things that can and need to be done in

terms of promoting more technology and get to the lower costs and allow that to happen. But the key thing on technology, in the storage technologies in particular and what we went through, in terms of what of what our EGT says, is one option we are looking at, just other bulk storage options.

But purpose-built, and the battery we've gone with, in our situations, the power battery, it is very specific, our requirements of what that battery had to do, its capabilities, we were very clear. And so in working with our supplier GE, made it very clear, here's what's -- got to do. And so there's purpose to what's happening and we thought about that in terms of what we wanted immediately and it wasn't for storage for storage, it was storage because this is what we are going to enable.

And the most important thing we are going to do is getting the feel so that the utility and the ISO and others can see? Yes. It is in fact doing what we want the system to look like, and it's being done in a way that we believe

it's a no-regrets decision; it's absolutely part of the long-term future. So that's really important. From a policy standpoint, I think it's really important to be promoting the new technologies in helping move things along, ensuring that markets are addressing the issues.

As an example, resource adequacy, for full delivery capability under the system, is that really needed for every storage resource that's added, if you've got a system that's completely saturated with RA, you really need to be procuring storage to add RA when you've already surplus at this time. If you say, ah, well, I'll start with something else, I'll add to it. So, policy needs to look at, as I think as Praveen said, look at where you need to be in the future, what are the decisions you make today and how do they fit into the future 10, 20, 30 years from now.

MR. SHELTON: Okay. Great. Well, not a lot of technology items that came out of that. There was the case where I asked the question and got a different answer. So, clearly, I expected

actually for us to hear more and maybe we will as we get questions. So, I think, do we have about 25 minutes left, 20 minutes? Yeah?

CHAIRMAN COWART: We'll see how it goes. At least 20.

MR. SHELTON: At least 20 minutes. Okay, good.

CHAIRMAN COWART: Alright if we open it up?

MR. SHELTON: You have the floor.

CHAIRMAN COWART: Alright. Well, I've seen some -- some cards have been up for a good while, and I'll -- You are pointing to Heather. Heather has been up for a while. Let's go.

MS. SANDERS: Okay. Thanks. Great panel. I'm very excited about energy storage as you all know. In the development of the California Energy Storage Roadmap, what was it, two years ago now, and that thing is still driving policy. So I'm very excited about this. And one of the things I really reacted to, was cost determined through procurement, and we really

agree that this is important because as the technology matures, costs come down, and we can't be sure of what that is, and so what I want to emphasize here is that it has to be in all cases.

In research it's important but also in -- these are void of cost models, so one of the biggest concerns we have is a requirements to put out a cost bogey, so that the market then doesn't do its job in procurement to give you the cheapest solution. So I wanted to add that to the conversation, because, yes, in research it may mislead to the capturing of what the true benefits could be, but at the same time, we may artificially establish a bogey for procurement of these things, that we don't want to do. So I just need us to think about both sides.

The question I have is, you talked about, you know, needing to go to the utility to understand their needs and their issues and, you know, I think this is an area that DOE can help, and we really recognize that in California in terms of planning, you can't just plan for peak

and deterministic. I think we all know this. And then, helping us as the utilities get through these tools, and one of the areas, we've been looking at and can help with is there's the notion of deferral framework.

When you do a distribution system plan, you come out with hundreds and hundreds and hundreds of projects. Ours is almost 1,000 pages long for our system. And so we need a way to filter through that and say, okay, you know, these types of projects can be deferred with a portfolio distributed energy resources, whether it's storage and a combination with energy efficiency, demand response, but we need a way to do that. We are kind of stumbling through it right now in California as we look to the attributes, but what we really need is not to understand our needs, what we really need is not necessarily that it will work, but how it will work.

So when you start to apply these solutions, and you know, in regulatory it's really easy to say, oh, just take up a whole bunch of

smart inverters and they'll provide VARs on as well. But then the flip side of that, there's no discussion of, you need sensing, you need control, you need communications, you need coordination for protection, you need coordination with the wholesale market, so we need help, and this is another area. We need help to sort through how this all works.

One of the things that's challenging about the stack benefits model is metering. So, if you are going to provide wholesale, you know, regulation energy, you are going to provide a utility distribution deferral, and you are going to do demand side management. How do you meter that? How do you deal with it in the times the way the market structures are?

So, yes, needs are important. Help us understand, yeah, maybe it's, you know, five days. So again, it's about availability, durability, dependability, flexibility, and affordability. So, I think this is another thing, you know, that I think I keep every time I go into a Subcommittee

meeting I have to say this. I think one thing that's really important for us, is to understand this equivalence. If we don't build the substation, and we defer it with DER, what's that equivalent?

A substation is here, it works, we know what it does, it's available. It's dependable. We know what it does. We know how it does it. Do the DERs do the same thing, or more? Are they durable? Are they going to be there forever? What's the contract term? And if they go away, what happens? And then the flexible, if we say five days, we don't know which five days. If we say five hours, we don't know which five hours. So, do they have the flexibility?

And finally, the affordability; and this is, again, timed up to that procurement emphasis, is let the market set the price. Don't do it at an avoided cost, at what that substation would cost, because it's really, really hard to measure what you don't build. And so I think those are, you know, two areas where the DOE could really

help us, as utilities figure out how to make all of this work in concert with the industry.

MR. TOOMEY: I would also like to add that that same work needs to go along to the PUCs, because after doing the very long procurement processes, then need to justify that same procurement, or that same decision to the PUC, and obviously a lot of understanding and work needs to go into these decisions, and so they have to relay that same message again to the PUC, it would help everything along if everyone is included in that process.

MR. DAVIE: There are a couple of things your comments highlighted, Heather, one is, you know, with the planning that goes on, and in California at the PUC, they've been doing planning and they've said, you know, we don't need more capacity, and they've said that in the last couple of their procurement proceedings, even though there's very clear testimony that there's a huge flexibility problem, and a huge over-generation problem, that is just flying down the road, a

train coming, you know, ramming into California in terms of renewables we've purchased, they are going to be curtailed and spilled because there's not a load to use them given the lack of appropriate flexibility in the system. So, that's one.

Second, I think you kind of reiterate my point; which is, the questions, reluctance Utilities have in terms relying on it. They know the tried and true, they know what they can rely on, and so what is it going to take? And I guess I would turn back to you, Heather, in terms of, what is it we have to do to, you know, SoCal Edison -- for SoCal Edison, to where you are comfortable relying on that storage project to replace and not build a substation.

MS. ANDERSON: And all I would add is, a couple of other questions that are related to your questions. You know, what's the hierarchy of the uses, and who controls that? And if you are getting a signal from your RTO saying, you know, you have to be available for this at this time, or

at this amount, you know, does that override other uses, and how do you sort of set that hierarchy up. So lots of those questions are really great questions.

And then the other thing that struck me was when you said, don't just look at avoided costs, let the market figure it out, well how do I -- how do I get my Commissioners to say that, to agree to that, and that's not how they are seeing things right now, and so how do we provide the framework and the foundation for them to be able to get to that point?

MS. SANDERS: I don't know, but I'd really like to know, because we just can't get over it. There was a time when avoided cost made sense, because the technology wasn't there, the competition wasn't there. It made sense, now it doesn't. And so, I don't know. We have some regulators in the room that may be able to help us with that. We are getting there. I think demonstrating the success for the procurement should get them there. We've successfully

procured a lot of storage, cost-competitively, much less than an avoided cost for demand-response, for example.

MR. TOOMEY: In terms of that, also, I wasn't implying -- I didn't mean to imply earlier that it should be priced at the avoided cost or somewhere near the avoided cost, it's more about the justification and procurement. If you know that you have a T&D deferral, but the storage can provide multiple uses, if you can quantify those. So, you can justify that, yes, the battery costs more than the transmission upgrade, but holistically it is the most beneficial path forward.

MS. SANDERS: Yeah, it's really a timing consideration. It's an after-procurement comparison rather than a before-procurement bogey. It's the timing consideration.

MR. KATHPAL: And on that issue I think the avoiding cost analysis is usually good to get storage on the menu in places where it's not being considered. I think California and Southern

California specifically, as you said, is a lot farther ahead. So, I think it's sort of a two-stage process where the analysis that users avoid in cost, justify storage's consideration as an alternative. The actual procurement that you are talking about clearly would be set by the market.

And, you know, you raised the idea that your company has procured a lot of storage costs competitively. I think that alone should be a market for other states, so I think Commissions, consumer advocate, utilities should all take notice that in this specific cases, this one being the need for new capacity resources, where SCE procured storage economically. If the conventional ways are followed without storage being considered as an alternative, that creates a prudency risk.

And I think that is something that certainly the utilities' CFOs will probably be thinking about is, you know, if I keep running down this road, if building peaker plan after

peaker plan after peaker plan, what kind of risk does that create for my shareholders if the cost recovery for those is denied, when the evidence is out there, clear as day, if you go look for it, in the proceedings in California, some of the papers from DOE, and from other analysts, that storage is a lower-cost alternative.

CHAIRMAN COWART: Carl?

MR. ZICHELLA: Thank you, guys. This has really been incredibly, incredibly informative. A few things leap out to me, that I just wanted to bounce back, reflect back to you, is maybe key needs that DOE can provide listening to all your presentations but, you know, the things that I seem to take away as the commonalities are, you know, basically analysis, particularly focusing on system needs and the benefits storage. Perhaps the most important one that I think I've heard over and over again, is the valuation and identification of services and products, making that discrete and real, sort that getting some idea of, and ending some of the

discourse about where these things land.

I mean, we keep running is it a transmission asset, is it a generation asset, how do you value that. Well, I think there are cases where it's both, we need to be able to value the services appropriately, and that's a really, I think rich area of work to value and identify the services and products. Obviously, financially they have different values in different parts of the country, but the value to the system will be, I think something that's more consistent and discrete, and may be easily identified.

The viability of the projects to deliver services, I think a lot of that work probably has already been done, you know, but there is an educational and communication challenge, I think Ellen was talking about; especially in some parts of the country where this focus hasn't been as intense. You know, you've heard of both avoid and do new demonstration projects, which I thought was kind of interesting, but to focus on actual projects that are meeting real needs. I think

that's a really good thing.

There is a track record out there now, it seems to me that, as Heather pointed out, getting more of a sense of how to sort out how all of this works, you know, the functionality, how you track in meter, letting the market set the price, these kinds of things, DOE can probably help think through some of that. It's a good one that I think we can put our finger on.

One thing Ellen said earlier about it's not just about electricity; well it's not just about batteries either when we are talking about electricity. We have some major projects appearing, and they are getting legs now, we'll compress their electricity storage on a very large scale in the West, we are starting to see projects that could really take advantage of fly wheel technology specifically for frequency response, but possibly as the technology evolves for modest load following.

So I think, you know, we need to be open to all flavors to meet the suite of needs, and

some things can meet multiple needs. And gives them greater value, we, I think part of that analytical frame for DOE is to, I think, to help understand how these various technologies which have different cost profiles, can perhaps solve for some of the situational needs that we see in the system. And as Doug's technology can be dropped in almost to anywhere now, you know, those flywheels can too. You know, you may not be able to locate -- compress their electricity storage just about anywhere, but you might eventually, as they start to turn towards using pipelines and that kind of thing.

I'll just stop there. It seems like those were the big ones for me is the valuation, and identifying the services and products. That's really one of the biggest things, because that's where the revenue streams are going to come from to keep this thing going forward.

MR. DAVIE: And, Carl, I'd like to just build on what you said there, which is make sure you are identifying the performance requirements.

MR. ZICHELLA: Yes.

MR. DAVIE: Don't specify how you are going to do it, specify what you want.

MR. ZICHELLA: Yes.

MR. DAVIE: Don't write a rule or regulation that says, synchronized, or compressed --

MR. SHELTON: And that rule applies to every new technology, right? I mean, demand response.

MR. DAVIE: Yes. Across the board --

MR. SHELTON: If you do that, demand response is going to show up to meet a lot of these needs and compete with storage, right.

CHAIRMAN COWART: Sue?

MS. TIERNEY: Thanks. Great panel, and really appreciate it. Thanks, Chris, for setting this up, it's very, very helpful. I have two questions. The first one, anybody can answer, and the second one is probably to Doug. And so, on the first question, I'm interested to know on this point that was just made, in a procurement for

actual market performance, as opposed to something which is trying to condition the market and get some new technologies out there, so I'm talking about real procurements now for something that is technology-neutral, where you describe the services and functionalities that you need, as opposed to saying the technology.

So, right on that point, how much of the experience to date, on procurements that we've seen in the market, from California to anywhere, is actually technology neutral, performance oriented, in the ways that you all were describing that I totally agree with? Versus procurement that are still being designed for storage, as a carve-out, the way that some places have procurement for solar, as a carve out; so how much have we actually seen in the market to date? So that's for any of you guys. And then a second one for Gary is, I am trying to wrap my head around your -- I said Gary -- Doug. It's a four-letter word, Doug, Gary, sorry, I'm sorry. In your package with the LMS100 that's the hybrid storage

and that GE system, I'm having a hard time seeing how the battery is durably seen as a zero carbon resource.

Because I'm picturing a world in which you are injecting power into that system from the grid, or from your resource, and if there are portions of the time when a fossil unit is on the margin, how it's greenhouse gases. So that one is just clarifying how the structure of the package works.

MS. ANDERSON: I'll just jump in and say, I mean, the only thing that comes to mind in terms of procurement that can be broadly technology neutral, in which we have many experiences, really just capacity or resource needs, so 200 megawatts is needed by this utility, and that is a pretty narrow approach that wouldn't encompass all of the different kinds of needs that we are talking about.

I mean, we did, we had some experience with that, where XL was expecting natural gas to meet -- you know, to come back in the bids, and we

had a distributed solar product that actually beat natural gas head-to-head in that -- and that was a first in Minnesota for that to happen at the Commission, but that's the best example I can come up with.

MR. KATHPAL: So, on the procurement question, we've seen a spectrum of practices, I would say on the worst end, is a capacity procurement, that's technology specific, and names the legacy technology, but it says --

MR. SHELTON: Yes, it even says that you would give preference to certain classes of that technology, right?

MR. KATHPAL: You know, it's terrific marketing by some turbine salesman to get written into a procurement like that, but that from the storage industries point of view that's the absolute worst case, right? Not only are you not on the menu, but you are deliberately excluded from it. But you know, it's not out of malice, this comes to the point about education that I think we've been echoing around the room the whole

morning, it's because the relevant stakeholders don't know storage is a viable alternative.

Next would be procurements that are nominally all source, but again, because storage hasn't been contemplated, it hasn't been anticipated, the evaluation framework is narrowly defined in a way that we don't think has captured all of the benefits of storage. So, it's incomplete, or in some cases it's inappropriate, where the metric being used is -- For example, LCOE, right, LCOE of any capacity resources a terrible metric because, you know, you have to make a utilization assumption for the denominator, and then from there things get better.

So we have seen -- we have seen procurements that define a range of technologies that are ineligible, probably the most structured one was the one that Southern California Edison brand, where they said, okay, this much -- you know, this is our overall need. There are some flexibility as to which resources could mean how much, but they knew that gas was going to come,

and storage was going to come, and demand response was going to come et cetera.

It's that middle area where all the technologies are eligible the evaluation frameworks need to be defined and improved that I think is a huge challenge right now for industry, and probably one DOE could help with. It's something I think we are all on the developer and solution provider side, it's something we are working on every day.

MR. SHELTON: Very practically speaking, you can download Southern California Edison's procurement document, right, I mean it's a great example, and also PJM Manual 11 is the ancillary service manual, spectacular example of great work by people, you know, it was done probably 15 years ago, they had no anticipation of storage, but they wrote it as a needs-based manual.

MR. TOOMEY: You really stole most of my thunder there.

MR. SHELTON: Sorry.

MR. TOOMEY: PJM and frequency

regulation market is asking any product to perform, four seconds. Energy storage happens to be one of the more proficient at doing so, which is why you are seeing so much deployment there. The best, just a needs-based case, and then Southern California Edison out again, asking for local capacity that could come in any form. They ended up procuring 250 megawatts, I believe it was the first round. A lot of it behind-the-meter, something that was generally new, but the benefits are there, and they saw, and storage was performing a lot of that role.

Some of it was rooftop solar or in a demand response type program, for behind the meter, you have some solar, but batteries can play in that market, and it's just describing -- that's more of a program, even though it's kind of specific. It's not asking for storage specifically, but they are there, and they can play in that market.

CHAIRMAN COWART: Janice?

MR. SHELTON: Doug, she had a question

for Doug as well.

MS. TIERNEY: I had a question for Gary.

MR. SHELTON: Gary, the other guy on the panel.

MR. DAVIE: One quick comment on the procurement. The thing that is very important for Commissions, in particular to understand is when they authorize or order procurement, be careful what you ask for, you might properly limit what happens. And in the procurement for Edison, for example, they were told to go get, local RA capacity, with a certain area, and so there was a quandary that the utility had over -- you add in all reserve things besides the LCR that I need, how am I -- Am I able to, can I, should I value that because you offered it and somebody else didn't but they could have? So there is an issue over the fairness the equity, the process, and you know, it's very important in procurement to say, what I need, but to not limit the utilities procuring in terms of valuing other things that are offered.

MR. SHELTON: Yes. It's sort of a vast issue, right? So if you go to the grocery store to buy vegetables, but fruit is on sale, you'll want to get the fruit too. Right?

MR. DAVIE: Well, especially if it comes, you know, you buy fruits --

MR. SHELTON: Yes. It comes -- it's for free, you get a free apple if you buy some celery.

MS. TIERNEY: It's like a tomato, which is, you don't know if it's a vegetable or a fruit.

MR. DAVIE: Yes. And you know, the second example I give, is the procurement that's resulting the Commission acted last Thursday, Friday morning the RFO's issues obviously got written, the actual resolution got changed. On Thursday afternoon there were some discussions that was very informative about the requirements, and now the RFO would come out, and the purpose of the RFO was to address the Aliso Canyon problem. But it what was earlier drafts of the resolution, it had 4-hour RA requirements, and full capacity deliverability capability, but they specifically

discussed at the Commission meeting, those weren't requirements.

So now, we are trying to solve a problem, to the extent those other things are provided, that's excellent gravy, but you've got to have the potato, and the gravy is optional. And so utilities, Commissions and utilities need to be real careful in terms of what you want and are you creating barriers to say, oh, this project can't compete even though it's great for Aliso Canyon, but it doesn't have -- it's not in the right area, or things like that; so, very careful.

Changing real quickly to the EGT, and I would suggest maybe a follow-up conversation in more detail, but let me give a real quick explanation. With the EGT -- Without the EGT, for example, a system has to provide spinning reserves, and the way you provide spinning reserves is you have a thermal unit online, and you back down, so your reserving capability form a thermal unit. Backing it down means you are reducing -- you are moving it off of its optimum

load point.

With the EGT you can allow that unit to go up to its optimum point, because I'm going to provide the spinning reserve services, from my EGT with zero GHG because I can meet all of the performance requirements, I can go from zero to 50, I can meet the -- I can be 10 -- or 20 percent of my award within less than a second, the requirements are 8, I can be at full load, and in less than 10, I'll be there in about 6 or 7, the requirements are 10, so my hybrid meets all the performance requirements, and rather than just operating 5 percent of the year as a peaker, I've got the other 95 percent of the year, where I'm providing spinning and it allows a re- dispatch so that two things are happening.

One, a unit that was being backed down, can go to full load, another unit can be turned off, so I am now provided the resources and the spinning is coming with zero GHG behind it. There is no energy behind it. And so that's a real quick explanation of what's happening, but I'll be

happy to go into more detail with --

MS. TIERNEY: And you are literally injecting from the LMS100?

MR. DAVIE: Well right now it's an LM6000 --

MS. TIERNEY: Okay.

MR. DAVIE: So its 50-megawatt blocks, and what we have, so it's an integrated package, and it's basically, under the hood, is an LM6000 in storage, and you are sitting there in the driveway or at the side of the street, with your ready light on, and you can take off and go, but you are not sitting there idling with your gas-only engine, ready to go.

MS. TIERNEY: Thank you.

CHAIRMAN COWART: Okay. Now, Janice?

MS. LIN: Thank you. Great panel, guys. I wanted to build on something that I think it was Mike said, and he said, this is not a technology issue; it's a market adoption issue. It's about helping utilities understand their needs and understand their options including storage for

meeting their needs, and I think later the statement was expanded to include regulators, maybe some other key stakeholders, and I think DOE, in particular has been doing some really amazing, leading work that's helping with this, the DOE database, awesome resource like a million heads worldwide to go to resource for projects that are online.

These regional meetings; I think are really well attended, when DOE puts on a regional meeting for regulators, the regulators show up. It's amazing, they take time out of their day, they spend a whole day to learn about storage, and from my experience in participating in some of these and many other similar stakeholder meetings, I think that one way to make them even more effective is to include more work.

As part of that, maybe a little more advanced work to identify some of the regional challenges, because what I've seen happen even at like some of the New York meetings I've attended, is there's a lot of information about storage, but

it's that connection to, well, you know, I get, it's all this useful stuff, it's a case study in California, not so helpful to me, it's really linking the capabilities to what are my problems. And I think with just a little bit more investment and a little more advance preparation these regional meetings can help bridge that gap.

But how do you get Ellen's regulator in Minnesota really tuned in and interested to figure out and do something, because if it's just an information dump it's all too easy to say, well, it's going to raise my rate, and so it's not ready and I'm not going there. But if the one thing, and one thing that we've seen in California and other markets we worked in, is when people can agree on what the core problems are and see an objective array of solutions, they are more willing to take that next step, and make the effort to see if it works.

And I think then in that way DOE can be a tremendous catalyst and that extra human step will just put all the tools that have been built

to work, because there is such a great array of tools, but they are not really using it, because they haven't made that mental leap, that this can actually be a solution for me. And the other thing I wanted to mention, is this procurement that Edison did is really, truly amazing.

I know you guys are all really familiar with it, but just historically, you know, in the California, the legislation, and the docket, you know, Edison was probably one of the -- you know, leading voices against a storage requirement in California, and then here we are in implementation and out there, and the number one leader in storage. So I just wanted mention that we produced a short 5- minute documentary about that procurement, about the legislation, the regulatory implementation, and the procurement, we did it with AES, GE and Edison, sponsored that video. And it's free and available online, and happy to send the link to everybody to check it out.

CHAIRMAN COWART: Right, but either you should, or we should ask ICF to send the link

around. Thank you.

MR. KATHPAL: Can I respond to something Janice said? I think the idea of the advance work, to understand regional needs before regional meeting is a really, really good idea. I mean, just -- what was it, last month, I think, there was a Southwest Workshop, that DOE and regulators had together. The elephant in the room there, is that the utilities in the Southwest if you actually go through and read all of their IRPs, which we have, and add it all together, there's over 10,000 megawatts of new gas-fired peaking plant.

This isn't coming out of, you know, like a long-term model that some consultant is running nationally, these are the utilities actually putting this down, saying, you know, each of them, you add them all up, there's 10,000 megawatts of peaking plants. That's the kind of issue that you could really create a dialogue around, and scope some studies around at a workshop like that; right? What does the world look like if we take

half of those, all of those and built storage instead.

MS. ANDERSON: And I'll just add. I would say all of our IRPs have that as well, more or less. Maybe not 10,000, but it's in everybody's plan. Yes.

MS. REDER: Yes. I guess my thought was along the -- Doug, you had one bullet in your slide deck, and I wanted to pursue that a little bit more within some context here, and it was the denial of the extent of the reliability issues are really contemplated in the lab as DER activity. And it seems your comment was from, you know, the variability and just maybe not taking that into full account, and the lifecycle implications.

However, it dawns on me that perhaps in the distribution space, we are in a situation where, you know, the dependability, durability, flexibility aspects of this asset, we are not necessarily able to quantity with a reliability context. And I wonder if the operation side of the equation couldn't help us be the leader in the

dance, if you will, to put metrics around this aspect. I'm wondering if you could just kind of add some comments here, to perhaps fill in this gap, that we didn't have time to discuss.

MR. DAVIE: Well, my comment on the denial, is around the issue of the renewable integration in California, and what is happening, and what that means. That, you know, the infamous duck curve is out there, and they talked about it in terms of a curtailment problem, the real issue is it starts as an over-generation problem, and over-generation is a reliability problem, and has to be resolved. And you know, the basic assumption in California was, well, just curtail it. Not a problem, we'll dump it.

Not a good policy decision, not a good repair cost decision, but that was a presumption, and part of it was built around, because we got till 2024 to solve it, and we didn't see it happening, and I think originally the Cal ISO was not particularly supportive of needing to do sooner rather than later. Last year they did come

around and realize, yes, the problem is coming sooner, and it's bigger than we are seeing. They were talking about the thousands of megawatts that were being curtailed day after day after day, earlier this year.

Now they were able to achieve that with negative prices in the market. However, as you get up to meeting 5-, 10-, 15,000 megawatts of curtailed, now they are going to have to be doing some of the -- they are going to be picking up the phone or some other way to deal with that. And administratively from a functional standpoint, how many people are going to have to add to the control room to be calling generators to disconnect, or are they just going to shut down the circuits. There are some real issues that are out there, that Cal -- that ISO is now coming around to it, but there's been a denial of the significance of the problem, the need for flexibility.

And that was what was building; we were looking at storage as well as other options in

terms of ways to provide the flexibility that is now provided by keeping combined cycles online. You keep them at half-load, that's how you get our flexibility, but it creates a Pmin burden that is blocking renewables from being used, but you wanted that plan to be offline, but to be able to respond immediately. That's the denial, I think there are progress is being made in it, people are seeing that, but it's now more, I think of an economic -- more economic to add the flexibility as compared to curtail the renewables.

MS. REDER: Yes, Pat. I know you have some work going on in the metrics aspects, but this is an area that just begs for some more specifics, I guess.

CHAIRMAN COWART: That actually leads to one of my two questions. And one of them is, has anyone calculated any specific circumstances what might be called the net carbon benefit of storage? That is basically following up on the point that Doug just made, that if you are not curtailing your renewables, and you are not having to run

additional spinning reserves then, in fact, the combination of those two things, you know, is yielding the carbon benefit.

MR. SHELTON: It's my market -- Go ahead.

MR. TOOMEY: We are definitely working with E3 in California right now, on some of those.

CHAIRMAN COWART: To calculate that, because that's a very powerful argument in a lot of places around the world including in Europe.

MR. SHELTON: It is very market specific and very dynamic.

MR. TOOMEY: Of course.

MR. SHELTON: So, yes. I mean, it's challenging, but once you -- if you have a very confined, defined future, you can make a statement about it, but how many of those do we have, right. But generally it's a reduction of a significant amount, and I don't know, Praveen, if you have any numbers off the top of your head that we've done, but I don't recall them.

MR. DAVIE: Yes. Absolutely, we have

done that. We've done work, you know, and the work I showed earlier was based on using PLEXOS Model during sequential stimulations going from an hourly to a 5-minute for 2019th. We've had some other consultants our specific EGT in terms of the benefits, in terms of reduced systems costs, savings and ancillary services, GHG reductions, I don't have the numbers specifically off the top of my head, but gave the EGT project a three-year payback.

A three-year simple payback on the investment, just from those savings alone, that didn't even address the reduced wear and tear and equipment. But I can provide more follow-up information on that. But, yes, we have looked at it, and it is not insignificant in terms of the GHG benefits. Originally that was our focal point of going after it, as we got into it, we found there were a lot of other benefits besides the simple GHG reductions that's at the heart of basically California does.

MR. SHELTON: Yes. NOx and SO2 are

huge, right, for the standby?

MR. KATHPAL: Yes. There is a very brief analysis that the Energy Storage Association submitted to EPA related to the Clean Power Plan. Comments on that policy that included, just a quick calculation of the emissions reductions for NOx SO2 to CO2, that was based on the very simple assumption that you are running a combined cycle plant efficiently, and you are substituting for output of the peaker plants.

And it showed a significant benefit, just on that basis. I think what you are talking about to do it on a net system-wide basis, goes a lot further, and there may be -- I think one of the more recent papers from NREL where they modeled an amount of storage equal to the California legislated targets. They modeled all of the Western U.S. I believe that had some carbon-reduction figures in it.

MR. SHELTON: It's pretty straightforward to do the math on the PJM -- PJM and the Market Monitor Report, what has changed in

the frequency regulation market. So it's mostly batteries during frequency regulation. You know, kind of know their efficiency levels of most batteries. You can do the calculation there, it's mostly kicked out coal, that was doing frequency regulation, so it's pretty straightforward. In an early study done by Beacon with DOE actually developed a methodology for that, with KEMA, and I think DOE was a part of it at one point.

MS. ANDERSON: And just to say that our state, and a number of other states, that are not necessarily in red, and in California have greenhouse gas reduction goals, and obviously clean power planning, planning in many states, still. And so that would be really valuable, and that's not -- when we talk about how to meet our greenhouse gas reduction goals, storage has never been on the list, and so that will be really useful information.

CHAIRMAN COWART: Well, this is now leading to a question I wanted to ask you, which is you mentioned the thermal storage, and hot

water heaters, for example. Yesterday in this Committee we were talking about the smart charging of electric vehicles, and when I think of the suite of resource possibilities that we are going to need in order to integrate a very large fraction of variable renewables, I think we need all three of those things. And so, I guess my question to the panel -- and I don't want to -- If we don't have time for an extended discussion. But would you support the writing of the performance requirements for storage in such a way that if someone can aggregate a lot of hot water heaters, or a lot of smart-charging electric vehicles to meet that performance requirement that -- Do you think they beat batteries? Or batteries always win? Or what?

MR. KATHPAL: That question comes to a lot of what Heather was pointing out as to, on a grid system, on the utility system, you need something to be available, and durable, and dependable, and all those other things. So, if that's part of the requirements, then absolutely.

You know, whatever the most effective and cost-effective technology is that can meet the needs and create the benefit for customers, we welcome that.

MS. ANDERSON: Yes. And I would say for sure, we need both hand, and you know, in an early stage, states like ours where those hot water heaters can be a little more cost effective, probably right now, but the combination will be optimal over time.

MR. DAVIE: I would very simply say, don't write the requirements for storage. Write the requirements for what the system needs, and let us, the suppliers, the innovators, figure out how we are going to deliver that to you, in a way that you are confident and can rely upon that to keep the lights on.

MS. ANDERSON: Well, and one more thing that, you know, it's not going to be the case again, in every jurisdiction, but the greenhouse gas component of that is also important too, because, for example, in Minnesota, where you are

shifting to off-peak you may have a higher greenhouse impact at this point in the grid, and so that's something that might be a measuring factor as well.

CHAIRMAN COWART: John?

MR. ADAMS: I've been cutting my questions down. The first, does any of the markets have a storage model, and the dead market optimization; any one? No.

MS. SANDERS: Yes.

MR. ADAMS: Yes, California?

MS. SANDERS: Yes. California has an energy storage model, it's called the Non-Generating Resource Model, it co-optimizes the operation of energy storage, both the (inaudible) full negative. So, charging through its full discharging provision of energy in the market, so it's been there, what, three years? It's not really used because of all the other things that they are saying, but I think we have hope.

MR. SHELTON: And New York has a designation of a resource type, I think coyly

named Lesser; it's a limited energy storage resource.

MR. ADAMS: Yes. We've got a definition, but we don't have it really optimized, and that's what I'm asking.

MR. SHELTON: But is that modeled? I don't know. I don't know how that would ever have been modeled.

MR. ADAMS: Okay. My second question: Doug, you held that device, I noticed you were providing services only in the energy providing side, and I was wondering, well, why not. When you are charging, you ought to also be able to bury that thing and provide ancillary services on both sides. Can you just explain why not?

MR. DAVIE: Well, one of the reasons is that from where we are right now in California that adds complication, absolutely, we can do it. You have, we will have the capability with the project of going instantaneously from minus 10 at any point, to plus 60 at any point. However, because of the rules that regulations of what's in

place right now, is 50 megawatts, and that's the only reason, John.

MR. ADAMS: Okay. And can you sell, zero inertia? I know it's not a defined term anyway, so I've got to ask you to just imagine. Can you respond fast enough that you act like inertia on the system?

MR. DAVIE: Absolutely. And we have the studies done, and I've got curves in there and presentations, you know, can talk with you later, but to show the response of the EGT alone, versus the response of the hybrid, and whether it was voltage, whether it was frequency, the EGT is way faster, or way more accurate in arresting, and bringing it back to where you want to be.

MR. ADAMS: Thank you.

CHAIRMAN COWART: And Jeff, I think you have the last question. Mark, has a question too.

MR. MORRIS: Yes. You know, this comment about some of that carbon benefits that, you know, Richard brought up, I just want to comment. There's a regulatory construct we see in

the West between California, Oregon and Washington, somewhat, where, because we have a performance standard for base load, fossil fuel units, plus RPS standards, which is a regulatory construct, that if you bring renewables to a part of your base load portfolio, you are forced to go peaking turbines to confirm that. They call them peaking turbines, but they are not actually peaking turbines, that are being used for an artificial peak that's caused by the renewables being forced into the portfolio.

We looked and because of this regulatory construct, this forcing folks to single-cycle turbines instead of even combining cycle ones, they would be counted as base load, we are actually promulgating a worse carbon outcome, had we just not left everything alone. And where I'm heading with this, is the clean power plant doesn't affect the same thing. It's going to compound with that construct, because again, the single-cycle peaking turbines aren't being counted as base loads, but yet, are being used to firm all

the qualifying base loads, renewables being brought into the portfolio.

Where I'm going with this, is that we've always wanted to articulate this into the integrated resource planning process, that looks at life-cycle risk of these technology, and there's not a good set of data for policymakers to actually source to say, Utility, you need to consider, when you do your Monte Carlo gambit, if you are building towards an efficient frontier model, that this is the net carbon actually cost of or benefit of storage versus single peaking turbines. And here is the risk of the regulations change to actually qualify as part of your base load resource over the lifetime of that asset.

The other thing we don't really have is any type of levelized cost on an annual basis, because we were talking, because of the proprietary relationship of some of the sales, but again, to even have those to say, hey, utilities, when you are in this IRP process, here is the list of levelized cost numbers you should be using as

opposed to just making the numbers up. Because that's what happens a lot today, is there's not expertise when the stakeholder consultation happens, to actually say, those were actually good numbers to hang your hat on, of what the lifecycle risk or benefit of storages versus all the capacity you had in technology.

So we would love to have it either from industry or from DOE, it's this concept that talked about the Grid Modernization group yesterday about this, there is not a Black's Law Dictionary of who to source as a credible source for these facts. And it doesn't have to be perfect, but even a range would be useful to policymakers to say this is what you need to be talking about in these dialogues you are having about what you are planning purpose -- you know, your planning is.

So, I guess there was not only a question there, but Praveen you and I have talked about this over the years, and is there -- you know, in the industry, is there any push, whether

it's through the National Energy Storage Group, or the state-based one, to actually give that kind Black's Law, reference source for a range of costs.

MR. KATHPAL: Yes. And that's something that the Energy Storage Association is active in now, trying to get more involved in being a source of information to the integrated resource planning proceedings that are happening nationwide. I don't see the inputs that the industry or DOE would provide as much in the category of levelized cost, but probably around installing costs, and operating characteristics, and I would warn anyone from providing those without also providing some kind of framework for valuation because, you know, it's not ultimately about the levelized cost, coming out of a particular resource, it's about what's happening on an overall system.

So, I think whether that's about, you know, fuel use or emissions, carbon emissions, that that holistic view can be applied to storage, can be applied to peaking turbines that you are

seeing in your region, and I think in most cases it will show that storage is the cost-effective alternative.

MR. SHELTON: Yes. Praveen, I think, pointed that it's out of a lot of the comments of the panel. What you draw the circle around when you do the LCOE analysis, is critical for storage. You have to draw it around the whole system. You can't just draw it around the asset. That's the challenge for storage, and I think that is area that DOE can help with. When you mentioned then load it's a great example, it's a drag on the system, that storage can help solve, that it plays into that LCOE.

CHAIRMAN COWART: Now, Mark, I think you have the last question.

MR. LAUBY: Thank you. I just wanted to clarify something with regard to nerve standards, and specifically there was a comment made that storage cannot be used for contingency reserves, and the current VAL standard, VAL 002 calls for -- Howard is -- believe me, Howard is

calling me with the full answer here. It talks about operating or continuing reserves, and both the spinning and non-spinning. And storage would clearly, you know, fall -- easily fall and qualify for the non-spinning portion.

It just has to be able to respond within a certain time period, which I know storage moves really quick. The new VAL 002 tough that's in front of the Commission, eliminates that distinction completely. And all it talks about is just reserves, and we leave it up to the balancing authority, and the RC to figure out how they are get that reserve over to demand response, the storage, the spinning, the non-spin, it doesn't make a difference, so relief is on the way.

MR. DAVIE: Absolutely. It's on the way, we are making comments in the 801-629 --

MR. LAUBY: Yes.

MR. DAVIE: -- next week. Things are moving in the right direction, but although everybody is in agreement, what should happen and you do, there is still paperwork that has to be

cleaned up, and that's the price --

MR. SHELTON: Doug, to be clear --

MR. DAVIE: -- they are reluctant to make the changes until they know it's trickled down.

MR. SHELTON: Your comments, Doug, were about the fact that it wasn't clear, right. It wasn't that it wasn't allowed, it's just that it wasn't clear that it was allowed. Was that --

MR. DAVIE: There is ambiguity, and ambiguity is bad for investors, and it's on the path to getting cleaned up, but that's just an example of something that was done and it -- Congratulations to all that are working for NERC and others, but it's an example of something that needed to get cleaned up, and it is getting cleaned up, because people are recognizing. Yes, that was a mistake.

MR. LAUBY: And we are checking on the WEC Standards, do you understand, there are regional standards, and then there's national standards, and we are trying to harmonize all

those but there may be an outstanding WEC standard we are going to take a look at. In the meantime, though if there's an issue, we can certainly issue some guidance with the help of Cal ISO.

MR. DAVIE: You'll have our comments Monday.

MR. LAUBY: Great.

CHAIRMAN COWART: All right. Chris, panelists, thank you very much. (Applause) We really appreciate it. We are ahead of schedule, and we are going to adjourn this meeting ahead of schedule, there were no members of the public signed up to address the Committee, and I would just in closing -- Oh, we do have a couple of announcements. One is that we have a mobile device that someone left in the room, and Rachel has been --

MS. FINAN: It was left on that side of the room yesterday.

CHAIRMAN COWART: So I think we'll --

MS. FINAN: We'll hold onto it.

CHAIRMAN COWART: Yes. We'll leave it

with ICF, and I'm sure someone will be contacting you.

MS. HOFFMAN: I guess, before we close, I just want to give my -- express my gratitude to Wanda, Rich, and Sonny, and of course Gordon is not here, but for all the work and support you did for the Committee, so I really appreciate. I would like to thank you all for your support on that.

(Applause)

CHAIRMAN COWART: And I will especially thank the others named. The Subcommittee Chairs have -- and Sonny, have really delivered a lot of great service to the nation, and to the Department, and it's been a pleasure to serve with them, and with you all. I'm sorry I'm not going to be here in the next meetings, but I know you have a good agenda, so I look forward to hearing about it. And good luck to Sue and Carl, and we would have loved to hear the news from you guys.

MR. ZICHELLA: Mr. Chairman, before we adjourn I have one thing, and I think Sue -- I'm

going to defer to Sue --

MS. TIERNEY: Go on.

MR. ZICHELLA: Well, I just wanted to suggest here that the EAC provide some note of our appreciation for your leadership over the years. I'd like to move that we work with the Department on some, at least Certificate of Recognition for the work that's been done by you, Rich. And of course everyone who has been working with you, but you have been a remarkably effective Chair, and I've appreciated working with you, and I'm sure everyone in here agrees with that.

So, I'd like to make a motion that we collectively come up with a token of our appreciation for our outgoing Chair, Richard Cowart.

SPEAKER: Second.

MS. TIERNEY: All those in favor, aye, let's do it.

GROUP: Aye.

MS. TIERNEY: And I would also like to add that there should be a resolution of

appreciation for Sonny as well, these two gentlemen are just incredible resources to the nation and we are going to miss you.

SPEAKER: Absolutely.

MS. TIERNEY: But you are not going away.

CHAIRMAN COWART: All right. Thanks everybody. We are adjourned.

(Whereupon, at 12:14 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.

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