UNITED STATES DEPARTMENT OF ENERGY

ELECTRICITY ADVISORY COMMITTEE MEETING

Arlington, Virginia

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P R O C E E D I N G S

(1:12 p.m.)

CHAIRMAN COWART: Good afternoon, members of the committee, guests, members of the public. This is an official meeting of an Advisory Committee of the U.S. Department of Energy. And as such, everybody should be aware of the fact that a transcript is being prepared and will be made public.

There is an opportunity for members of the public to address the committee, and, as always, there's a signup sheet. Any member of the public who wishes to address the committee will have an opportunity to do so at the conclusion of the meeting tomorrow. And the signup sheet is located out in the foyer. I've seen a couple of names on it, so it may be that we will have an opportunity to hear from people tomorrow afternoon.

We've got a full agenda this afternoon, and I'd like to just begin by letting us introduce ourselves -- go around the room and say hello.

It's always great to see you when we get here. And I think this is an unusual meeting. I don't think there are any brand-new members of the committee here today. That's pretty unusual, anyway.

So, let's start down there, with Bob Curry.

MR. CURRY: My name is Bob Curry. I was, for six years, a Commissioner in New York, where my sons ended up on the Electricity Advisory Committee at the DOE, where I still sit. I'm more associated now with SolarCity and its participation in the rev and coming into New York in the East. So, I continue to bring slightly different perspectives to everything I can get my hands on. Thanks.

MR. THILLY: Roy Thilly -- I ran an electric utility owned by 51 communities in Wisconsin, Michigan, and Iowa. I'm retired. I sit on the NERC Board, but I am not here on behalf of NERC. And I cochaired the Eastern Interconnection Planning Collaborative on behalf

of DOE.

MR. HUDSON: Afternoon, everyone. I'm Paul Hudson. I spent five years as Chair of the Texas Public Utility Commission, and run a little ERCOT-focused consulting firm these days.

MR. SIOSHANSI: Ramteen Sioshansi - I am a Professor of Industrial Engineering and Operations Research at Ohio State University.

MS. SILBERSTEIN: Pam Silberstein, Power Supply Counsel with NRECA -- glad to welcome you all to Arlington.

MR. BALL: I'm Billy Ball, Chief Transmission Officer at the Southern Company.

MR. COE: Hi. My name is Carlos Coe. I'm with a renewal energy company called Millennium Energy.

MR. ALMGREN: Ake Almgren -- ORKAS Inc. I'm also on the Board of PJM and Active Power.

MR. CENTOLELLA: Paul Centolella -- I'm a former Commissioner from Ohio and longtime energy consultant. I have my own small consulting company, Paul Centolella & Associates. Despite

what that says, that's my principal affiliation. I do still have an affiliate agreement with Analysis Group, and have been on this committee for a while now. So, pleasure to be here.

MR. TILL: I'm David Till. I'm with the Tennessee Valley Authority.

MR. GELLINGS: I'm Clark Gellings. I'm a Fellow with the Electric Power Research Institute.

MS. REDER: Wanda Reder -- I'm with S&C Electric Company as the Chief Strategy Officer, and I'm a member of the IEEE Board.

MR. POPOWSKY: Hi. I'm Sonny Popowsky. I was the Consumer Advocate of Pennsylvania for many years, and now I'm the Vice Chair of the EAC.

CHAIRMAN COWART: Richard Cowart -- previously, the Chair of the Vermont Public Service Board, and for the past 13 years, a principal at the Regulatory Assistance Project, and Chair of the EAC.

MS. HOFFMAN: Pat Hoffman, Assistant Secretary for OE.

MR. MEYER: David Meyer. I'm in the Office of Electricity, under Pat.

MR. ROSENBAUM: Matt Rosenbaum, also with Department of Energy Office of Electricity.

MR. PARKS: Bill Parks. I'm with DOE, and I'm going to talk about grid modernization today.

MR. BOSE: Anjan Bose, from Washington State University. I'm a Professor of Electrical Engineering.

MR. LAUBY:: Mark Lauby, NERC.

MR. MORGAN: Granger Morgan, from Carnegie Mellon University.

MR. MORRIS: Representative Jeff Morris, with the Washington State House of Representatives.

MR. MOUNT: Tim Mount, Professor Emeritus of Applied Economics, from Cornell.

MR. ZICHELLA: Carl Zichella, Natural Resources Defense Council.

MS. ZIBELMAN: Audrey Zibelman, Chair of the New York Public Service Commission.

MR. VAN WELIE: Gordon van Welie, ISO New England.

MS. SANDERS: Heather Sanders, California ISO.

MR. ROBERTI: Paul Roberti. I'm a Commissioner at the Rhode Island Public Utilities Commission.

MR. SHELTON: Chris Shelton, from the AES Corporation.

CHAIRMAN COWART: All right. Thanks, everybody. As usual, we like to begin our meetings by hearing from Pat Hoffman (inaudible) turn it over to you.

MS. HOFFMAN: Okay, I thought I'd give you an update, but first things first. The QER has not come out yet. It should come out in a couple weeks. But things are busy.

I think, as some of us have talked right before this meeting -- but for the record -- there isn't a lack of things to do in the electric sector; a lot of things dynamically happening at the states internal to the Department -- a lot of

coordinating that's going on. We're trying to really focus on some of the priorities in which we can help the industry advance and evolve in the grid modernization space.

We have been looking at opportunities to really focus on the engineering of the system such that we can better define some of the system requirements, and what some of the needs and opportunities are for advancements -- whether it's at the transmission level or at the distribution level. So, some of our activities have been primarily supporting the QTR, which is the Quadrennial Technology Review, the QRE, which is the policy annex to that, but also spending some other parts of our time really thinking about, what should the distribution system components have, as we move forward? And I know we'll talk about that as part of the meetings today.

I would say the biggest challenges is more time and resources. Some of the conversations we've had really focuses us on how much resource you really -- as you look at,

whether it's New York or California, how much time has to be spent in helping analyze the system, but analyzing the different architectures. I know that PNNL's here; is going to talk about some of the architectures.

But it's not easy space right now. There's a lot of influences that are hitting the electric sector. There is a lot of needs. There is a lot of uncertainty. And so how do we continue to move forward as an industry, given all the different constraints that are current on that?

And then you also have, on top of that, just the whole set of cyber security and physical security issues. So, we're spending a lot of time trying to keep our hands in different buckets, but also pay attention to different needs and what some of those opportunities are.

With the other thing that I guess I will tell us is, as we're getting to the closure or the wrap-up of the Recovery Act programs, I'm really pleased with some of the success stories that have

come out, and the cost/benefit analysis, and the hard work that everybody has put together from day one on the Recovery Act when we had an RFI to say, hey, we want to really look at investing $4.5 billion in the electric sector. You know, how do we really do that from a cost-effective -- but yet open the door from an IT space, and a sensing, and measurement, and technology space?

And I've seen a lot of advancements in that area. And so it's really pleasing, as we hit the October and September timeframe, to look at even some of the analysis that's been done on the interconnection level, some of the advancements on the distribution system, the deployment of the synchrophasors -- a lot of innovation, I think, that has come across, and some catalyzation in the industry itself. So, I really appreciate that.

Some of the needs, really, that I have is, once the QER comes out, we'll probably sit down and talk through a set of recommendations. Bill's going to talk about the Grid Lab Consortium. I really would like your advice on

probably some priorities moving forward, because there is so many things to do in this space. What do you see as the highest priorities?

The other thing is, probably a constructive conversation. I really appreciated this committee being the grounds in which we actually can have a very constructive debate around topics, so that we can actually show the transparency of the different sides of an issue -- of what's being either debated in industry or happening out there. So, we'll continue to push topics forward on this committee where we want some transparency, and we want to have that constructive discussion.

So, I'm sorry I interrupted the flow. Did I interrupt the -- okay.

CHAIRMAN COWART: No, you were the flow.

MS. HOFFMAN: Okay. All right. I wasn't sure. I was like, okay, did I interrupt -- did I jump forward? But that's what my priorities are. And then, as other things come up during the meeting, we can talk about those, going forward.

Okay, thank you.

CHAIRMAN COWART: Are there any questions for Pat Hoffman, following up on that?

Carl?

MR. ZICHELLA: Pat, the QER's coming out in a few weeks, you said. What's the timeline on the QTR?

MS. HOFFMAN: I think the timeline on the QTR is -- we're going to have a Capstone Summit, like, the third week in April, and then the QTR will be finalized after that. So, you're probably looking at May for the QTR.

CHAIRMAN COWART: I'm noticing that Lynn Orr is not here as the next speaker on this agenda, but I think he's on his way. And so I think we'll turn to Bill Parks.

MR. PARKS: (inaudible) to join me up here, just for a second.

I'd like this to be a little more of a discussion. So, I have slides. I'll walk through them, but the intent here is, there's several things that we're asking you to engage in, and

we'll put those at the end as we go through.

We wanted to give you an idea of what we're doing, and get your advice. And, also, we've tried to assign roles to you, a little bit, and how appropriate it is, and how you react to that. Next slide, please. I don't have the clicker up here.

So, let me just take a minute and say that I am -- we formed a Grid Modernization Laboratory Consortium between DOE and 14 of the national labs, to look and to try to align activities on grid. And I am the DOE Chair of that, and Kevin Lynn is the Vice Chair of DOE, and Carl Imhoff leads the laboratory group in this area. So, all three of us are engaged constantly at trying to make this.

And the Secretary in the FY16 budget process -- which started a year ago -- identified several cross-cut areas, which I'm sure Dr. Orr will refer to. And one of them was the grid modernization, and that request went into the Hill at $350 million -- so a significant increase in

grid-related activities for the Department.

And what this is intended to do is align all grid activities that are happening -- so especially in the applied programs, OE and EE, with EPSA and the policy world being also part of the core of this. And then ARPA-E -- Tim Heidel's here -- and the Office of Science operate differently, but have links back into us and coordination with activities that are going on.

So, the idea is to align everything we have in the Department, and everything we have at the labs, and the grid space as a critical activity area. So, it's a tremendous opportunity, I think, for us at DOE to get as much aligned as possible, and also to align our activities and our partnerships with the outside world.

This was stood up officially, the Lab Consortium, October 30th, between DOE and, again, 14 national labs. We have teams that I'll refer to in a couple minutes from the labs, so we're putting a significant effort into this.

What we've been asked to do this year is

develop a multiyear program plan, and I'm going to just sketch that out a little bit for you, and come back to some questions on it -- and then to align lab activities across the labs, looking at both their expertise and their regional placement -- because, as many of you live everyday, the regionality in the grid space is an important consideration. So, we want to take advantage of that regional opportunity and expertise, and lay that out.

And just an example of that -- we have Brookhaven in this -- and with all the activities going on in New York, it's, how can we help New York, help Brookhaven? That's leading, for example, the smart grid activity in New York -- and have access back into their brother labs, into what's going on. So, give more support to the idea of whatever and whichever state or region is asking for opportunity. And there's examples across the country of that kind of activity.

And then it's also important that we ask the lab -- say, hey, take a look for us; what is

DOE spending? And it's around $100 million in FY15 this fiscal year, but there's also an additional $100 million in work for others, in activities that they're doing with states, that they're doing through, you know, lab funds. So, there's a couple hundred million dollars directly in this consortium activity that we are trying to align, and make sure it is really getting maximum bang for the buck -- and avoid duplication and things like that.

So, the other major thing that we're asked to do is to recommend to the DOE programs -- whether it's the solar program, or the smart grid program, or storage, or the buildings activity -- activities that we think align this in a way that we're going to talk about in a few minutes, and really create one overall DOE major operating plan on grid activities. So, that's a major, major activity for us and a change of operation -- how we run today. Next slide.

This is how the consortium was put together, and it's a busy slide. So, the red

boxes are DOE. This is chaired by Dr. Orr. Pat sits on this board. Thank you, sir. And Dave Danielson, from EE, and Melanie Kenderdine sit on this. So, they're the principals and the executive committee. And we met last week, for example.

We also have, on the left-hand side, a joint planning. That's a legal way for us to involve two of the lab directors, speaking for the labs. They can't do, by law, the fiscal aspects, so we have to separate out the fiscal activities and prioritization from the other activities, and that's the way we did that. Kevin and I are the leads for DOE. Carl's the lead -- and Brian Hannigan, at NREL, for the labs.

We have six activities. Don't try to strain your eyes and read what's in the boxes. I'm going to show you in a minute a little bit about that. But if you look, the second box on the left-hand side is the EAC. And what we'd like -- and this was teed up a little bit in some conversations through David Meyer's efforts -- and

what we'd like to ask is, is there a subcommittee, or some activity, or some way that the EAC can look at this and advise us overall?

We're going to also include advisement within the six major thrust areas that we've picked out -- and at that level, working through laboratories -- but we're looking at a big picture. And is this the right group, and can this -- and that was our suggestion, that we would want to tie that up, and see if we could get that role.

This middle green area represents kind of our core consortium leadership. It's our program managers (inaudible) secretaries responsible for the grid-related programs across those offices I mentioned -- OEEE, EPSA -- and through the grid tech team, into ARPA-E, into Office of Science, into NE and FE.

And in addition to that -- so we've met as a group, as well, over this, and the primary work since being stood up October 30th is to work on -- we have a draft MYPP. And I'll talk about

that again in a minute, as well.

Anything you guys would add to this so far -- Kevin or Carl?

So, this is a snapshot of the labs and the people engaged. Like I said, we've stood this up pretty hard, and taken it seriously. We have the six major areas that I'll talk to in a second, but these teams cut across a representation in a number of the labs, in all six of them. And we've reached even into AIMS, and to Savannah River, and others that, historically, you don't think about have experience.

But what we've found is, we said, not only think about where you have expertise today -- traditional programs at NREL, and Sandia, and Oak Ridge, and PNNL -- but think about what's emerging. What are the areas that are emerging that we have some expertise, and linkages that we don't normally think about, and how do we grow that next generation of expertise within the lab structure?

So, there's a longer-term cultural

aspect to this, as well, not just, let's go tackle the nearest thing. How do we create that body of expertise for the next generation of things? Because, as we all know, this is going to be a longer-term activity -- to modernize the grid.

What I wanted to do with this slide is just kind of connect very loosely, without getting into too much trouble, the QER, the QTR, and what we're doing. So, the QER is looking at the national energy need across the board. And, as Pat mentioned, the QTR is looking at, what are the R&D gaps with the technology needs within this space -- of which electricity is a subset of this? We're focused on electricity. This Multi-Year Program Plan is focused on electricity.

And we're laying out these six areas, which I keep promising I'm going to get to, and the task associated with that. So, when you see the draft, we've got about 145 tasks currently in the draft that we have. It's undergoing review internally, and we're hoping in the next 10 days, 14 days, that we would release that in some

capacity for you guys to look at and comment on. And we're holding a workshop April 22nd, 23rd here in D.C. to talk about it, and to get more input from the private sector and all the affected stakeholders.

And how that all lines up on the end is, how do we execute our programs? And so it doesn't mean that we're going to replace in every program, and do everything through the laboratories, by any means. It says "use the labs where it makes sense to use the labs, do the business that you do through (inaudible) direct, you know, partnership with industries or creators. Do the work with universities the same way you do them." You know, if anything, let's have better, tighter alignment among all that activity, but let's not take away the tools we have to get work done, and to get the right work done.

And, indeed, if you look at the FY16 budget submission, it includes increased work in the institutional space with states, as an example. And so we would look at, how can the

labs help inform and support both states, and regions, and DOE in that process, as an example?

So, the six areas that we've talked about -- and I think we talked a little bit about these last time -- and kind of focused on sensing and measurement, devices and integrated systems, systems operations and power flow, design and planning tools, security and resilience, and institutional support.

And so if you look at the last two, you know, and then the first four, it's how do you create the visualization tools? How do you hook, at the distribution level, all the devices together? How do you have interoperability? How do you have security throughout the thing? What are the regulatory and policy issues that need to be informed by what's happening in the technology world and vice versa. You know, that's really the interface that we're looking for and the institutional space.

How can we create better planning, operational, and decision-making tools -- kind of

a platform -- one of the basic platforms and frameworks that we need, whether it's grid architecture or, you know, modeling design in a new world where you can have, at a distribution level, millions more data points that somebody is paying attention to in some manner?

And what are the possible arrangements that you want to think about, and the connectivity that you want to think about, so you don't have to invest piecemeal in everything as a state or as a region, and not think about this more holistic framework?

And what can DOE do and the labs do to kind of help set that stage, and help facilitate that kind of discussion?

So, in addition to those six that we looked at -- which have outcomes and targets that will be in MYPP -- we've said, at the end of the day, we want to really be able to show outputs from each other's activities over a five- year period; in addition, some cross-cutting outputs, because these six things are not parallel in

separate entities, anymore than the programs that are working in this space are parallel and totally separate entities. There are integration themes. And you guys can have this presentation if you want.

And so we've kind of targeted -- and the question that we want to pose in the April meeting and to you is, we've kind of picked three. And we've kind of picked the outputs from what we would actually demonstrate in conjunction, in partnership with the stakeholders, and what kind of outcomes we'll talk about on the next slide that we might be able to affect or really see in the longer term, on a national scale.

So, the first one is lien reserve margin grid operations. How do we think about operating this system with less reserve margin safely? You know, no impact on our liability, but taking advantage of more demand response, of more distribution -- you know, the fact that you've got all this distribution asset, and you can do more on the load side than you could in the past -- how

do you really affect that, and bring that into play in a safe, secure, and reliable manner? And that's really what that group is targeted at doing. And what is that fundamental architecture or design of the system that you want?

The second one is, recognizing that we're going to go for more decentralized control, how do we get clean, resilient distribution feeders? What do they look like in the future? What don't they have today? How do we get -- how far do we have to take visibility into the distribution system to really operate it the way we want to? It could be operated to give consumers choice, to give consumers participation, and to really have, still, a reliable, safe, secure, affordable system, and use some of the attributes in it.

And lastly, the third one is, how do we tie grad planning and analysis so people can make better decisions, more informed decisions? So, I'll just give an example of that -- would be electricity storage. You know, when we were

working with Hawaii -- or in California and other places -- people are picking numbers of how much storage to put in. How good are those numbers that they're -- it's a high-cost, you know, item, as an example.

So, you know, can we be better and smarter about, what's the total impact? If you take a look at this as an integrated system, can you take advantage of other things? And the way that storage -- whether it's at FERC level or at state level -- is given credit for what it can provide to the grid also needs to be looked at from the institutional side. Decisions should not be made; it's just voltage, you know, stability. It's just frequency response, or it's just, you know, VAR control. It needs to be, what does something give to the grid, and how do you take advantage of the multiple attributes that it has to bring that, and then value it accordingly?

And I think people, you know -- we're guilty of this, and everyone else is -- making the best decisions with the best information we have

today. But how can we get ahead of this curve a little bit, and really understand the impact of the decisions that we're making? And that's really what we want to do.

So, we took a shot and said, okay, if we weren't able to do this, then the outcome that we would effect -- of which the DOE dollars of participation, the lab dollars -- would be targeted, but could not achieve by themselves, without the private sector, without the utilities sector, without the vendors, and everyone else.

And these are the kind of things that we thought we could shoot for. And we think they're directionally correct. The 10-percent reduction, the economic cost to power outages -- 33-percent decrease in the cost-reserve margins, and 50-percent cost in the cost of integration at the distribution level of all (inaudible) technologies.

Those are pretty aggressive, we think. And we argued about, you know, are those the right numbers -- with different numbers? And we'll be

glad to enter into those discussions -- and build some case and at a first shot of, you know, we could impact $7 billion a year in budget, and we could improve the grid operations if we were to do that.

It'll also ensure that we have a flexible platform for innovation in the grid, and that's another key thing that we want to develop.

So, in a nutshell, that's kind of what we're after. You know, we've got 100-some pages MYPP that we want -- it kind of lays out the case for us -- and we want opinions about. Is it valid? Where are the holes? What makes sense? Are there better targets? They're all inputs that we're looking for.

So, the questions the three of us would like to pose to you is, what role do you think the EAC can best play, and how should it be structured -- if there is, indeed, a role? And should you, indeed, comment on MYPP? I'd like to open it up for discussion.

CHAIRMAN COWART: Thanks very much.

Committee members all know this. When you want to speak, please put your card up, and I'll try to keep track of who's been up the longest. I think Granger --

MR. MORGAN: I'm not going to answer your questions immediately, but I just want to say what I think I may have said last time, which is, I don't think we know the cost of disruption to, say, a factor of two. So, I don't know how I'd observe that I've got a 10-percent reduction in the cost of reduction. And I have some thoughts about how you might refine those numbers, but the existing literature that I've looked through fairly carefully recently is pretty awful.

MR. PARKS: We would agree. And we think what we're going to have to do is create the indices that we're going to measure against, because we're not sure that they exist in totality today. So, one of the things we want to do early on is, how can we get at those -- what are the baselines today, and what is a legitimate set of baselines? And it may be a multifaceted set of

indices that we have to use to even get at something realistic, from our viewpoint.

Carl and Kevin, would you add anything to that?

CHAIRMAN COWART: Carl?

MR. ZICHELLA: Yeah, I just had a question about things that you're looking in your inputs -- if you could go back one slide, that would be great.

I notice -- the one you were just talking, with the percentages --

MR. PARKS: I'm sorry (inaudible).

MR. ZICHELLA: There you go. I noticed that you don't have any environmental performance indicators there. Given that we're in the midst of a very profound transition, being driven in part by our greenhouse gas emissions policy, requiring all states to take action, it very much affects the grid. And we have long-term goals. We have trajectories we're trying to get on here. It seems like one of those targets ought to be related to those environmental performance

targets.

MR. PARKS: So, thanks for bringing that up, because for trying to be brief, I may have left a little too much out of the gaps.

We have five attributes we're going after. Let's see if I can get them right -- need help -- clean is one of them, affordable, reliable, safe, secure kind of fits in one, because innovative is a fourth. And I'm going to miss -- no, secure is the last one, I think -- is it? Flexible -- sorry.

So, clean is in there. There's the President's goal that he has. We, of course, don't have an overall arching national agreed-upon goal for this. So, we went ahead in the direction of clean. All of the above strategy is clearly stated by the President and the Secretary, and is embedded in what we're looking at.

MR. ZICHELLA: Great. It would be nice to have, you know, sort of a target that jived with those goals.

MR. PARKS: We have that slide. We

embedded -- message received. We embedded -- it's a case of how to measure, and what's the balance points of all of those things, right? And we would argue that that's going to be, for the foreseeable future, regionally balanced -- because you're not going to see a consistent, 50-state, agreed-upon in this five-year timeframe that we're looking at. We'd have no indication of that.

MS. SANDERS: (inaudible).

MR. PARKS: Yeah, please.

MR. LYNN: So, I mean, I think it's a good point. I think we see it -- and I think Bill said this while -- we have tried to call it out, but we also see it pretty well in that 33-percent decrease in the cost of reserve margins. I think, you know, you put more wind and solar -- you're going to have to increase some of the reserve margins. We see that as a big piece of that.

You know, in terms of the 50-percent cut in the cost of DR integration, I think that all of the above strategy -- that covers the all of the above strategy, which is good, but, as we all

know, solar and wind -- you know, specifically solar on the DR side, as far as the one that's making the inroads the fastest -- and so I think that's -- I think you can look and see it covered in that particular bullet, as well.

CHAIRMAN COWART: Chris?

MR. SHELTON: Sure. On that last point, I think, you know, all 50 states are dealing with, you know, EPA rules, as we -- I mean, it's sort of the elephant in the room, I guess. But that's very known, and it's present now, and a lot of people are being mobilized to deal with it. So, it seems like it would be helpful to, you know, inform indirectly, I guess, those activities. I know it wouldn't be directly linked or directly associated.

But the comments that I actually wanted to have were about -- I think it's great. I support it. And I think -- I had a question about, how does this interface with RPE activities or inform them in any way? And that was one question.

The other is, are you going to be taking a holistic architecture view of the electric system as part of these activities? I see you have one stream that seemed like it might, but I would encourage that that doesn't get lost, because it's come through a lot of papers from the EAC over the last few years. So, it's been -- we've been hitting that note over and over again here.

MR. PARKS: So, let me turn those -- and then -- for a reason. So, the architecture is a major piece. You'll see that jump out in this. There's activity. And the answers to both the previous question and this one -- we can't get ahead of the QER and the QTR, so bear with us a little bit on timing of everything.

But the points are absolutely valid, and we agree with those points. And I think you will see -- you know, there was -- GridWise Architecture Alliance helped the QER process in the last year, and I think you will see a continuance -- alignment of those activities, and

activities that we're doing, and that they have regional presence and outreach last year. I think you'll see that continue, as well.

So, that alignment continues, and we are trying to stay as aligned as possible with the QER, and QTR, and this activity. So, I think when you see that whole suite of things, you will see better definition of some of these topics, if you will.

And then Tim Heidel from ARPA-E is here, and I'll just ask him to speak in a minute, but I'll give him a second to collect his thoughts.

What we've done since ARPA-E formed is had a continuing -- a bunch of dialogue. And Tim sits on this (inaudible) activity, and follows things, and advises us. And he also asks politely -- includes us in things like his project reviews on GENI and that type of thing. So, we participate in that.

So, there's shared information back and forth. We each have a role, and we're cognizant of how the handoffs should occur. And we're

hoping that this process, as the QTR does, helps that handoff process better between RPE and the applied programs. But it's something we continue to work on.

Tim, is there anything you would add to that?

MR. HEIDEL: I'll come back to this in my discussion this afternoon, I think. You know, one of the things I'm going to raise is that ARPA-E plays a role at the very early stage of, let's prove a concept is possible. Proof of concept is the outcome. And yet, there's a tremendous amount of work that needs to be done after that initial proof of concept, to actually get something into industrial use.

And I think that I'm looking at -- this plan is, really -- the drafts I've seen and the discussions we've had -- a major part of this is actually pulling through from where we're leaving off with some of our earlier programs, picking it up, and continuing that work. So, I'm really excited about this, and I think that we've been

staying reasonably well aligned.

MR. SHELTON: That's great. I think it's a virtuous circle. So, I mean, if the what-ifs here and the visioning from an architecture activity point to new areas that need to be validated, then ARPA-E can mobilize industry to do that, and then it feeds the next cycle. So, I think it's really great.

MR. PARKS: Okay.

CHAIRMAN COWART: Audrey?

MS. ZIBELMAN: So, I also think this is a great concept -- I think particularly getting the alignment of the labs with these objectives, and so that we could all sort of have a very focus of, what are we going to work on?

I think, though, to build on the other comments, what probably -- and to be sort of a way of us thinking about this -- is that we are going to be, in the next five to ten years, you know -- and the states are looking at, how are they going to meet the 111(d) obligations, and how are we going to maintain reliability -- with the ideas

that we're going to have a system that's going to look very different and have very different resources, but we want to do so in such a way as to achieve certain objectives.

And that some of these goals -- and Gordon's just whispering in my ear, and I think it's absolutely right -- is the idea we can't control everything. But if we could focus on, you know, how do we reduce the costs of integrating DR by 50 percent? So, it's not as if these are the outcomes you're going to achieve; rather, the focus will be making certain that the studies are there, the technologies are there to allow us to achieve these objectives.

So, we can start saying, we're going to achieve 111(d), and cut power costs, and improve reliability.

MR. PARKS: Exactly right. That's what we're hoping to see from the states and the private sector.

MS. ZIBELMAN: So, with that, kind of just the real question is, how do you feel --

because you guys have been talking about it -- that the EAC could be most helpful, from your perspective, and, you know, what role you would see we could play?

MR. PARKS: I'll start that, and ask my colleagues to also respond. I think, as we indicated in the earlier side, having a subgroup of the EAC advise, kind of as a total-picture level of the connectivity of this, both within what we're doing and the connectivity back to the states, and regions, and private sector would be helpful.

This group represents a nice cross-blend, so it's getting those perspectives, and, really, advice on how to move forward is the number-one thing that we would like. It would truly be helpful to have you look at the MYPP and comment on it within the rules of EAC engagement.

CHAIRMAN COWART: Mr. Parks, thank you very much. And I think I'd like to return to this conversation, because we may have more comments on this exact point. But Dr. Orr is on a very tight

schedule, and we're going to flip it to him --

MR. PARKS: I yield the floor.

CHAIRMAN COWART: -- and then come back to this.

MS. HOFFMAN: So, I'd just like the honor and pleasure to introduce Dr. Orr. He joined the Department -- what, you're on your --

DR. ORR: Three months.

MS. HOFFMAN: Three months -- a whole three months and two hearings under your belt.

DR. ORR: No, more than --

MS. HOFFMAN: More than that -- okay. So, well- seasoned at this point in time -- but want to say that it is a great honor to work for Dr. Orr. He's done a great job in bringing together the science and energy programs in the Department, and is going to talk a little bit about the QTR and, I think, some of his objectives, moving forward.

So, with that --

DR. ORR: So, thanks, Pat. I'm cognizant of the fact that I'm here talking to a

group that knows way more about the topic of my remarks than I do. But if anything, the first few months at the Department of Energy has gotten me accustomed to that. It's been an absolutely intense learning experience, and even the parts of DOE that I thought that I knew well, it turns out that there was much to learn.

And I would say thanks to Pat and her team for patiently explaining what they do, and helping me to understand both the challenges and the exciting opportunities that lie ahead of us. So, thank you, Pat, for all your leadership and your hard work on behalf of the nation and on behalf of all of us who are trying to figure out how to use the funds that we've been given as wisely as we can.

But I am glad to be able to talk here today, particularly about the future of the grid, because I think it's absolutely fundamentally enabling of the energy transitions that are underway in a big way now, and that I think we'll look back on this time as one of a rapid -- not

only rapid growth, but, really, a change in the rate at which we make the kinds of transitions that are ahead of us, as we really transform the nation's energy systems.

And, of course, I'll say a word of thanks to all of you for volunteering your time. I've served on enough of these kinds of advisory committees -- and including a long stint on the Basic Energy Sciences Advisory Committee -- to know that what you say is taken seriously, and that the expertise you bring to this is something that we don't really have access to in almost any other way. So, we really do appreciate what you do.

So, let me just talk briefly about three things, and then I'll be happy to try to answer some questions, if there are some. And if there are, I'll do what we did in our hearing in the House of Representatives Appropriations Committee, and that is, I will cheerfully hand them off to Pat, and she will get to answer them.

So, we actually had a good time, I will

say, in that hearing. And I guess I never expected to say that, but our little team, I thought, responded pretty well to a series of fairly tough questions, with me offering some vague generality, and then the subject experts chiming in to add flesh to the bones. So, we survived together what can always be a little bit of a trying experience.

So, let me say a few words about sort of where we are in the energy sector in general, and what it is that's driving us in the DOE programs, what we're doing in response to those things, and then I'll say a few words about what I think are ways that you can help us.

So, we're really at a point where we're making critical choices for the future for this country. In my view -- and, I think, in the Department's view -- we're embarking on fundamental changes to the energy systems as a whole. Those are driven partly by the fact that we do need to reduce greenhouse gas emissions. I think there's plenty of evidence to support that,

but we need to do that in a way that protects the economic security of the country and deals with the energy security and national security aspects of that, as well.

The President, of course, understands this, and has made a national commitment to combating climate change. And he's given us the goal of reducing U.S. greenhouse gas emissions by something like 26 to 28 percent below 2005 levels by 2025. Now, to some folks, 2025 seems like a long way away, but those of us who think about the scale of the nation's energy systems and the work that will have to be done to accomplish that see it as terrifyingly close. And I see enough nods around the room to suggest that I'm not the only one that holds that view.

On the other hand, if you look back over the last -- I don't know -- 5, 10, 15 years, remarkable transitions have happened already. There have been big transformations. The natural gas situation has changed dramatically. The price of various renewables has continued to come back

as we've marched down the learning curves. And we're now thinking about changes in the way we manage electricity transmission and distribution that I think were hard to even imagine a few years ago.

So, I guess what that means is that it's useful to integrate over something longer than a day or a week -- that even, you know -- sometimes, I get to the end of the day, and I say, "Well, did we advance the ball today? Gee, I don't really know." But if you integrate over a little bit longer period of time, you can actually see that we have made some progress -- not that we've solved every problem.

And so, of course, what we're here to talk about today is how we attack the ones that are next and ones that are really important.

So, there's some more good news. In a previous reincarnation, I led a team that really tried to look hard at all the primary energy resources we have available, and ask, you know, how do those compare to what we're trying to

supply for human needs? And out of that, of course, emerged what you all knew anyway -- that is, that there's no shortage of primary energy resources. There's plenty of wind, and solar, and geothermal, and fossil, and nuclear energy resources; it's all about how we convert those through some process into energy services that supply -- that are kind of woven into every aspect of human life.

So, that's where the thermodynamics appears. That's where the ingenuity of all the scientists and engineers can go to making energy conversions that are more efficient, that are cleaner, more reliable, and that supply human needs in a way that we will need to do for the world as a whole, and not just the United States.

So, you say, "Okay, well, that's the big time challenge. Now what?" That was easy to say, and hard enough to deliver. You know already that the Department is working on an all-of-the-above energy strategy; that we really want a fully-diversified energy system, because that's

resilient in the face of both economic and resource challenges -- or even things like storms, or earthquakes, or other natural events. So, having a diversified system is very important.

And I think what that means is that we need to have a fully-diversified research portfolio. It needs to be a portfolio that goes across energy resources, that goes across ways to transform those, that goes across time scales for application, that is rich on the fundamental scientific side -- because that underpins all of what we do -- but it's equally rich on the applications, where -- and we need to do a good job of letting one illuminate the other.

One of the things that our Secretary did when he came aboard was to do a reorganization of the Department, to bring together the science and energy programs under one -- under Secretary. And he talked me into joining the team. The rate at which I joined was slower than we anticipated, because it took the Senate a while to get around to voting. But the good news is that the folks

have been working hard on this all the way along.

So, let me move now to the question of the grid, which, as I say, I do with some trepidation, since you all know so much about it. But I can imagine a world in which the grid is laden with sensors, has active controls available, is much more interconnected than the one we have now -- so less radial and more networked -- that has nested micro-grids within it, and that has a much more sophisticated system for assessing the state, and taking control actions based on that, which will demand not only the communications and sensing required, but the computational ability to do state estimation, and then, of course, active controls, and then even optimization in a way that's going to require much more capable computing resources than we have available now.

So, that fits a variety of the activities of the Department -- and particularly in the science and energy part of it. Some of it involves the cross-cutting efforts that you've heard a bit about, as well, on the grid. Others

involve things like exascale computing and the ability to really go to the next generation of much -- not only much faster machines, but the ones that have -- where we can take full advantage of the massively parallel machines, and to both operating systems and architectures that allow us to use those effectively, and programming environments where we can do the fine-grained simulation that will be needed as we go forward.

And then, of course, there is the whole power consumption issue, as well. It's not going to be okay to have to relocate a power plant next to every great big computer. We need to be much more efficient in the way we use electricity even within the computing environment. So, this is a process, of course, that requires science. There are plenty of fundamental mathematical issues of how we collect the information and make use of it. But it will also involve a much broader cross-section -- much of which you represent here today -- and it's pretty clear that no single entity or constituency is going to be the one that

makes all these decisions.

And, indeed, as I know you all know, the DOE is not the regulatory authority in any way here -- that this is done in a variety of settings at the state level and regional level. And so we need to understand these systems, and treat them as big, complex systems that we make use of as we go forward.

So, we have multiple activities underway that are related to this. One is the Quadrennial Energy Review. Now you've heard about this already, so I will be very brief so I won't repeat too much of what you've heard. But it's an attempt to look at the state of the energy infrastructure as it stands now, to identify places where it's vulnerable, and to think about policy alternatives that might reduce those vulnerabilities, and provide a way forward.

So, energy transmission, storage, distribution that link supplies of fuels, or carriers, or byproducts, and other uses. So, you'd think that taking a snapshot of where we are

would be straightforward, but that would be wrong. It really has been a very challenging effort, and it's underway in interagency review process now, and is said to be soon to emerge. For all of my three months at DOE, it has soon to emerge -- so I understand there's some flexibility in how you interpret that. But it does seem to be getting close to being publically available.

And, of course, the electricity infrastructure is a very interesting component of this -- and an essential component of it. Much of it is owned and operated by the private sector, of course. And then much of the legal, and regulatory, and policy frameworks occurs at levels other than the federal government.

So, that creates some interesting challenges, but it also gives us the opportunity to be a convening power to bring people together for discussion, where we're not the deciders; we're not the ones that have to do this.

So, a parallel effort is the Quadrennial Technology Review. Now this is an attempt within

the Department to really look across all the ways that we take some primary energy resource, and put it to work -- whether it's through generating electricity that's used for all kinds of other things, or to manufacture all the goods that we really -- that, really, it's tried to be a comprehensive look.

And the reason is to understand where we stand now and where the research opportunities are, because as we build the research portfolio that we use to go forward, we want that to cover the spaces that have the most opportunity for impact where the kind of research that we can sponsor is able to have an impact.

And so, as we do that, we are busy thinking -- and mostly about the technical side of things, although we recognize that the regulatory environment plays an important part of that.

We've also done something that we've called cross- cutting initiatives. And my assignment at DOE has been to try to think about how we bring the science and energy programs

together when it makes sense to do so. And one of the ways we've tried to do that is to look at big, complicated problems where we have expertise distributed across the Department and across the national labs to work on it.

And one of the key ones, of course, is the grid modernization cross-cut. And I know from what Bill -- that you heard from Bill recently, so you've already heard more detail about how that might be in there.

We also have five other areas of cross-cutting research. One is in exascale computing. One is in using supercritical CO2 technologies to run turbines to take advantage of the thermodynamic cycle that allows you to take advantage of the high mass densities of supercritical CO2 -- and a variety of others.

And then as part of the grid modernization area, we've formed a Grid Modernization Laboratory Consortium. And this is an absolutely deliberate attempt to take the assets that we have distributed across the

national laboratory system, and put them to work on a problem that really is of great national interest.

And you heard about the Multi-Year Program Plan, so I don't really have to say too much more about that.

Now let me close by talking just a little bit about the relationship with all of you. We understand that the investments that we make to deploy technologies has to be paralleled by a thoughtful investigation of the regulatory environment that -- and the business environment that all of you will work in going forward. I think it is pretty clear that changes are underway, and that will continue to take place. And, of course, the good news is that I'm not going to be the one who has to decide what we do here.

But, as I said, we can use our convening power to create a conversation that we hope will be fully illuminated by the science and technology part that we can bring to it, and in recognition

of the expertise that all of you bring, as well.

And I hope we can continue to offer the kind of technical assistance we've provided to states, and tribes, and local governments. We have some money in the budget request to continue to do this, and we're hopeful that that will be funded. For example, we're currently providing assistance to the New York Public Service Commission, to help with their Reforming Energy Vision Initiative. And we'd like to be able to do that -- to provide assistance to others.

And then, as we go forward, we -- the reason Pat and I were testifying before the House Appropriations Committee last week is because the FY16 budget is in consideration right now. So, I was at another hearing yesterday in the Senate, and it's clear from the two of those that there will be an elaborate discussion of funding priorities -- that might be the most polite way I can put it.

But, at the same time, I thought, in our hearing -- and yesterday, as well -- that there

really is a sense that the science and energy parts of what DOE does are very much in the national interest, and worth supporting, even as we debate what the level of support should be.

The Office of Electricity Delivery and Energy Reliability -- we're asking for a $270-million budget item. That's a significant increase, and a significant increase in grid-related funding -- up about 40 percent from this year's level. Now we'll see how far we get with that. But if the Congress hears directly from stakeholders that these are important issues to consider, then they're more likely to look on this as something that should be supported. So, if you happen to be wandering the halls of Congress and nothing else to do, perhaps you could help us make the case that these are things that really do matter, and that all of us should pay attention to.

And then last, you know, I think maybe the single most important thing you can do is to really help us understand. These are very complex

systems. There are regional issues and priorities. Whatever we do on the research side should be illuminated and guided by understanding as much as we can, and try as much as we can. The truth is that the kind of knowledge that you all bring to this is something that, really, we need to have as part of our consideration. So, thank you for continuing to do that.

I know that some of you have participated in QER and QTR and led consortium discussions, and thank you for that, as well. We hope you'll continue that.

So, let me stop. I'm happy to try to answer questions, but I'd really like to hear what you think the most important challenges are for the industry, what technology investments you're making, and how you think the business and regulatory models evolve. And then if you have advice on what the appropriate role for DOE is in these transitions ahead, we'd like to hear that, as well.

So, thank you very much.

CHAIRMAN COWART: And thank you. How much time do you have?

DR. ORR: How much do you need?

CHAIRMAN COWART: Oh, all right. Well, that's good.

DR. ORR: A few minutes more.

CHAIRMAN COWART: Are there questions? You anticipated my first question, which was your sense of the budget request.

DR. ORR: Well, it's certain to be a tough budget year. The initial statements ranged from "sequestration is not acceptable," from the standpoint of what needs to happen both on the defense and nondefense side. So, that's one marker. And then the corresponding marker is that, you know, "the budget needs to go down, not up," and that money's tight, so get used to the idea.

Presumably, things will end up somewhere in the middle, but the details, of course, remain to be fleshed out. Is that vague enough? Because I don't know the answer to the question.

CHAIRMAN COWART: Any other questions? Whoops, I'm sorry. Jeff was a little quicker.

MR. MORRIS: Thank you, Dr. Orr. You know, states are struggling with -- well, with recognizing with utilities the adoption rate of all these different technologies on their system -- whether it's EV cars, or PV solar, or home energy management systems -- and a lot of the utilities don't even know their own circuitry tolerances for this.

But on the other side of that, both regulators, planners, and utilities don't really have any Bayesian algorithms to look out and see what the adoption rate might be. If you look at where DNA medicine's gone with the type of software that's enabled it to do predictive and preventative medicine -- at what point do you think that we might have tools to do that same type of predictive and preventative engineering on the distribution system?

DR. ORR: Yeah. So, it's a really good question. I know it's something that we're

working on. I don't personally have a good prediction on that, but maybe Pat does. I don't know. You have anything you want to say about that?

MS. HOFFMAN: Well, I think we've set up a process where we're looking at open-source tools, and we're trying to go from stochastic to predictive in nature. We're looking at parallel processing. So, there is a whole portfolio in our clean energy technology -- the grid modeling program that we're working on. And I know that there's some advancements, as well, in RPE that we're marrying together, and hoping that we can capitalize on, as well, that you'll hear about a little bit later.

DR. ORR: Yeah, but no question that it's a good question.

CHAIRMAN COWART: Billy?

MR. BALL: I would just like to say thank you for your comments. I enjoyed them, and just personally would like to say how much I appreciate the inclusion in the increase in the

budget ask for Electricity Delivery and Reliability group. I'm very encouraged by that.

Also, very encouraged to hear in your comments an appreciation for what I believe over the years has really been the fundamental value of DOE -- which is that fundamental research. And I really think, no matter what the future holds, the more we understand about these fundamental research items, the better we're going to be prepared to handle whatever the future brings. And so I think your comments were just right on point for me.

DR. ORR: So, I thank you for that. I meant to say and forgot that the national academies did -- in particular, the National Academy of Engineering -- a while back identified what it thought were the most important innovations or inventions of the 20th century, and number one on that list was the grid.

And so I think our job, collectively, all of us, is to do that again, but to do it with the grid of the future. And think about what that

would enable, in terms of economic growth and in terms of providing reliable services to all of the people in this country -- and, by implication, to the rest of the world, as well -- because if we lead the way, then the world will follow. And it would be a better world because of that, if we can pull it off.

CHAIRMAN COWART: Nicely put. Anjan?

MR. BOSE: Going back to the budget question, you know, one of the problems I think this committee has always felt is that the budget for the grid work -- the kind of systems we're building -- has always fallen through the cracks, and has not been enough, in terms of -- it's much easier -- not from an R&D point of view -- but to convince people to have budgets on widgets. You know, you can build more transformers, or cables, or superconducting cables, and so on, but it's always hard for the private industry to put much research into the systems aspect.

And this is where we feel, at least, that the DOE can have a bigger impact, because DOE

is about the only entity that can actually affect this area. And, somehow, the budget process doesn't seem to kind of recognize that, and I wonder if you had thoughts on that.

DR. ORR: Well, yeah. I can't promise to personally fix the budget process, but I can say that we recognize that we need to do a better job of understanding these big, complex linked systems. So, the electricity system is one, but there's complicated transportation systems. There's all the pipeline systems. There's the -- if you think electricity is complicated, think about water.

And, as a society -- and, I think, as a former university person -- I think we have actually done a good enough job with thinking about those linked complex systems, and how we create them and manage them.

But we recognize that it really is an important aspect of this. And if you look in detail at the research portfolio that we've laid out for this, much of it is very much about

exactly that: How do we acquire much more information? How do we manage the system as a system, not just as individual components?

And that's -- there's a focus on this on our Quadrennial Technology Review, as well -- but both to look at the individual widgets and how they work in a systems perspective. So, very important question -- absolutely correct to worry about it.

MS. ZIBELMAN: I just wanted to thank you, actually, for the support that DOE's giving to New York. It's actually very valuable, and I think, you know, hopefully it'll be valuable back to DOE, because we're, in realtime, looking at these architectural issues.

But the other aspect of it, I think -- and it maybe helps in the budget -- is where DOE has always -- sort of from a standpoint -- has always been thinking about on a grid basis. What's happening now is, these decisions are affecting individual decisions. And so this is becoming a sort of mom-and-apple-pie -- is

healthcare and things like that. And so to the extent we can take the message that this is really going to help individuals reduce their energy prices, be more secure, and that we're really getting the grid down to that level is, I think -- maybe Congress will understand the relevance of what we're doing a little bit better.

DR. ORR: Yeah. Well, I'm certainly open to any thinking we can do about how to communicate better as to the importance of all of this.

CHAIRMAN COWART: All right, Dr. Orr. Thank you very much.

DR. ORR: Thank you. Thanks again for what you do.

CHAIRMAN COWART: I think we were near the end of the conversation with Bill Parks and team, but if you would resume -- yeah. We would --

MR. PARKS: (inaudible).

CHAIRMAN COWART: We've got to -- there may be more discussion, or you may have more

ideas.

MR. PARKS: Well, we'd like to hear from you about how you think you can engage with us on this, and any advice you could give us from where we are now, and as we start to try to bring, you know, our thoughts and MYPP forward, and how we can best integrate it with the rest of the country.

CHAIRMAN COWART: I'll make a general observation -- that I think you're right; that the expertise and knowledge base of the people on this committee is really impressive, and could be extremely helpful, if we can figure out how to ask ourselves sufficiently clear questions. And so one of the challenges, I think, for the Department is, can you put in front of us a, for example, a list of proposed priorities, and then ask us to comment specifically on them? That's an example of a concrete way that you could get some feedback from the committee in a discernible way, as opposed to just the general conversation about a lot of ideas.

Now within that, we recognize that sometimes what you get from us is well-informed reaction and dialogue about something that's a little bit inchoate. And that's okay, too, but I'm urging you to think of ways that you could, from your brainstorming, wow, it'd be really great if we could get the EAC to just give us feedback on this concrete proposal.

MR. PARKS: Okay. (inaudible) I think we can attempt to do that. I think some iteration needs to occur. We can take it to more specifics. The only caution I have -- for ourselves, as well as for you -- is simply, we don't want to get prescriptive. So, I think that iteration will become important.

MR. HUDSON: Bill, that was the tip of the spear at the various utilities -- at Gordon's shop, Heather's shop (inaudible) other places. There's obviously a tremendous amount of realtime working group activity, realtime interaction with all of the changes that's occurring.

And it strikes me that I don't have a

good idea of the baseline of information and the baseline of interactivity you have with all of what's happening out in the field, in realtime, in enough of a way to figure out how to give you good input from the folks that we are dealing with out there, kind of in a distributed fashion, on a day-to-day basis.

So, I'd be interested to know, you know, how you all touch all that information that's happening in realtime, to inform the development of questions around the grid lab stuff.

MR. PARKS: There's several things I lose sleep over; that's one of them, because there's so much activity at multi-levels today that's happening. And part of why we want to create, really, a cultural shift at both the DOE and the lab level is to get, you know, that information better -- and to have some better presence in the states and regions than we have today, so we can follow that better. You can follow some things from D.C., but you need to be out and engaged at the local level and the state

level to really understand things, from my perspective.

And I think that, you know, we talked about it in New York before -- to go to the other country -- one of our team leads, John Grosh, from California -- Lawrence Livermore -- is also leading the CA-21 program for California. So, we're getting connection in how the states are also reaching into the labs, and hope to see more of that across the nation, as a way of getting as much information as we can.

And we've talked about, you know, how can we best be a clearinghouse for some of that -- you know, especially -- we've done work, and we're continuing to do work -- and you'll hear from Debbie in a bit on the smart grid activities -- but there's just, how do we make that more accessible?

Well, we do know, as well -- we continue work on it, and -- guys?

RMS. REDER: I would add that the engagement's pretty substantial. The laboratories

are very involved in North American Synchrophasor, an initiative that many of the members here are involved in -- a lot of work with the working groups in the WEC, and working new-model (inaudible) et cetera.

I think it would be useful for us to baseline where some of the current touch points are, and then to ask the committee for where we see the gaps or white space where we need better connectivity. And I think that would help you guys sharpen some of your responses, so that the engagement is substantial. I think we can baseline that for you, and get that information back to you offline, and then we can better ask where we think we need more help.

MS. SANDERS: Yeah. I guess I would just say, you know, the question is, how do you take all that information in, and do something with it? And so we have -- I mean, you saw one of the slides that Bill showed. We had 66 or so people from 14 different national labs across the country actually taking an active role in writing

a Multi-Year Plan. And I think that's one of the things that I'm most excited about -- is that we've really got a lot of engagement.

And it's not only, you know, those people working on programs that DOE is working on, but, also, as Bill mentioned in one of his slides, there's a lot of work for others that's going on that can be, really, equally as important. And so not only are we're seeing what DOE is focused on, but what the labs are focused outwardly with, some industry, and pulling all that information together. I think it gives us probably, I would say, the best opportunity, at least, to hit the touch points that we need to pull together a plan.

And just real quickly is, you know, the question on priority. We do have this Multi-Year Plan coming up, and we did show some of, like, the very high-level national outcomes and DOE major achievements. And then not only -- if you get a copy of the Multi-Year Plan, there's, you know, about 100 or so different technical achievements of one grid architecture to one -- I mean, I think

that could be an opportunity, at least to start, you know -- to wrap your hands around how to prioritize, to give us feedback on what we're doing.

CHAIRMAN COWART: Pat?

MS. HOFFMAN: Just one comment that I want to add to the discussion -- and it's the debate that we've also had internally -- is, we recognize the regional diversity in all these topics. When you talk about visibility and priorities -- whether it's at the state level or even at the regional level -- that there's going to be a level of difference in priorities, depending on what region of the country you're talking about, and what some of those regional priorities are. And so it adds a layer of complexity as we move forward in this space.

And it's just something that I wanted to put on the table that we've talked about, and we recognize, but it's something that is included in the conversation.

MR. PARKS: And to elaborate on what Pat

said, I think, you know, our simplistic view is, we want to build a really full toolbox, and let people pull the tools out of it that they think is appropriate for their situation.

MR. CENTOLELLA: So, you know, I'm pleased to see that this is going forward. And I look forward to being able to interact with the plan and the team. You know, one of the things I really would look forward to doing is understanding the objectives that you've laid out, and how you got there, and having a discussion about whether or not these are the right stretch objectives -- or is there something missing?

A second thing that I do appreciate is the discussion about flexibility for innovation. And I want to talk a little bit about that, because I think this is important, and I want to bring it back to a phrase that you used a couple of times, Bill.

So, as we're seeing what's going on -- for example, in New York, where we're talking about animating new actors to participate in the

energy system, and what we're seeing in some of the other states -- we're looking at an electric system, you know, that may look quite differently from what it's been in the past. And I think you used the word "decentralized control" or "hierarchical decentralized control."

That may well not fully characterize the electric system of the future. We may see much more decentralized coordination with autonomous and semiautonomous actors who are influenced by system operators, but not necessarily dispatched by them, and markets develop in wholly new ways. And that development may be a fundamental source of innovation that changes the power system.

And so I would hope, as you go forward, that you think about, you know, different models beyond something that is more of an incremental change from what we've seen historically in the future of the grid, and how that might play out in how you create the flexibility for those different models to emerge, and to create emergent solutions in the system that may not be the solution that we

would plan if we were starting from the current framework.

MR. PARKS: Very helpful. We would agree, and I think you'll see that Tim agrees, as well. So, we feel that very much in it, and we're not trying to suggest that we understand there's a single solution point in the future. We want to allow that flexibility, too, of the multiple futures. How do we not also overly invest, as Dr. Orr was saying, in one single solution set in this? Because that can cost, ultimately, the consumer -- whether as a rate payer or a taxpayer -- way too much money, compared to what it could be if we really think this through carefully.

RMS. REDER: And the thing I'd add to that, Paul, is that part of our objective is to establish some tools, and enable the national discussion to identify, what are the right metrics to compare, and what are the gaps in our knowledge that we need to fill in with fundamental math or other things, in terms of control theory, to help us really get a nice, full, robust set of options

to consider, both on the traditional control, as well as the market side.

So, the intent is to be open and nonprescriptive, but to provide tools such that it could be an open and transparent process for all the stakeholders. And that's something that I would argue we really don't have today. And so that's part of our agenda.

CHAIRMAN COWART: I am conscious of the time. I'm prepared to go five minutes into the break, and take the cards that are up right now. Bob?

MR. CURRY: This may be just a continuation of your last comment, but is there a common dictionary, lexicon of terms that everyone agrees to in this universe that we're trying to address? Because I've seen wildly different things in wildly different places -- not too wildly.

And the second is, if the definitions are the same, are the baseline numbers the same -- quantification? In other words, it's got to be

something different between Alaska and California. But are the terms ultimately universal so that you can mine the talent in the six different regions where you have national labs, you can mine the talent in the regions that have ISOs, that don't have ISOs, that have active state commissions, not-so-active state commissions?

I remember in ARRA, there was not a common set of criteria that were deployed in evaluating. And so I ask as a threshold question, is that -- do you have that now, or is that something you anticipate creating?

MR. PARKS: We do not have that. And the scary thing is, we even find it within ourselves; operating within our own DOE lab construct, we struggle with that. And so I think it's a really critically important issue that we get common terminology.

I used DER up there. That means different things to different people in this room, as an example. So, we've laid out, you know, what we include in that as an example. One can argue,

is that the right list or not? But it's a list -- at least getting it out there.

One thing we did a few years ago in Hawaii, when we were looking at the Hawaii Clean Energy Initiative is, we brought in a group that kind of informed the entire Hawaii PUC staff. And then we informed the same information to kind of the leading 100, 150 people in the energy community in that small state. But everybody emerged with a common set of terminology, and it really enhanced the debate and discussion, and raised it to critical issues.

So, just those relatively simple things can make a world of difference if people understand the perspective from each other. And I really think, in the absence of that, it's going to be hard to make fast progress. So, it's something that we are very cognizant of.

MR. CURRY: Yeah. And just following along on that, to the extent that we can be useful and give you our perspective on the priorities, that's the baseline that we would have to be armed

with to be able to make that discretionary judgment.

CHAIRMAN COWART: Gordon?

MR. VAN WELIE: So, just building off the two comments from Paul Hudson and Centolella, which is, I was curious about your process for arriving at the objectives that you have up there, because I think the basic idea of getting some kind of cross-lab effort going is a good one. The question then would be, are you working on the right things?

And so I was curious about how you arrived at those three, and why you chose the percentages you did.

MR. PARKS: Great question. I'm glad -- I'm going to let these guys answer it -- no. We -- it's -- try and see if I can give a shorthand version of this -- lots of discussion, lots of discussion.

It started with a challenge from the (inaudible) level last year on, what are big ideas -- what are things we could really transform, if

we were to really apply a DOE lab activity? And it kind of emerged out of years' worth of discussions on those topics of the kind of things.

And I think the key is, in a very simplistic way, you know, we've got to concentrate on the things that we don't know or that are really confusing to people, and we know that that institutional technology barrier is one. We know that decentralized control, in whatever way that you see it and the understanding of distribution, how things connect to it, is very important. And I think we know that, you know, transmission, and reserve, and distribution interface are all important areas. So, those have kind of emerged in some sense of priority, and how we've picked those cross-cuts.

But what's critical to us is, the path that we arrived at is really important -- that we ensure that we get that cross-cut input into that -- that they're not just, go pick this linear target and go after that, but it's really a well-mixed set of things that interface this,

because it is multivariable. And so that's a simplistic answer. I'm not sure -- hopefully that made sense. I don't know if you guys would add anything.

RMS. REDER: I'd just add briefly, Gordon, that when the labs were first asked to come up with an unfettered sense of what would be the big, major steps down the field, the realization that we are achieving system visibility like we've never had it before, and dramatically improved controllability of options -- the notion of operating closer to the edge with more predictive tools seemed like a major opportunity, and then we translate that in terms of, so where does that make a difference?

And it makes a difference in the economic (inaudible) of the assets we have and the assets we procure in the future -- which gets to that issue of kind of reserve margin. The outages issue, also -- it helps us steer around some of those outages, and minimize the frequency, duration, and time under outage situations. So,

those outcomes kind of flowed from some of the early view of big, bold steps.

The other one I'd mention briefly is this notion of a substantially enhanced analytic platform (inaudible). So, I think that the analytics, and the regulatory process, and due diligence tends to lag oftentimes a lot of the technology possibilities. And so we tried to focus on opportunities we had to substantially enable that whole analytic and regulatory process, to sort of look at the benefit/cost issues.

The whole issue of valuation of DER is one that there's been a lot of debate and discussion around the country, and that was one we targeted early on where we thought we could make some substantial improvements. And that ties, then, into that third outcome of reducing the cost of integration.

And to Carl's point earlier, we know that the clean all-of-the-above future's an important part of this agenda, so that kind of spoke to that issue of reducing the integration

costs of DER in general. And to do that, you need common lexicon; you need better baselines that work around the country, as well for each of the individual regions. That's some of the thinking behind them.

MS. SANDERS: I think I would just add in, it was a pretty interesting process, from my perspective, about pulling these together, because we started with some very, very aggressive goals in certain places, and not so much in others. And I think as we brought in more and more people, we realized that some of the goals that we had initially set, we sort of kind of said, okay, well, what is it that we can really do? What is really achievable?

And it was nice, I think, again, trying to bring in all those different resources together, to bring some semblance to what we want to achieve.

And I think the other thing that I'm excited about, you know, coming from the EERE office, we've had a number of different folks on

either the SunShot Initiative, or Electric Vehicle Initiative, or all these different initiatives that are looking at one piece of the puzzle. And I'm really excited about looking at multiple attributes -- so, like, looking at the clean, looking at reliability, looking at flexibility, innovation -- all those things at the same time.

And I think that's the thing that, to me, is different about what we're trying to achieve here as part of this -- well, one of the things that's different -- you know, one of the things is, all the DOE offices are trying to work together; getting the labs all to work together -- but then looking at multiple attributes all at the same time, and trying to achieve those simultaneously is really different. And I think it's pretty exciting.

CHAIRMAN COWART: Thank you. Carl, you have the last question.

MR. ZICHELLA: Okay, great. First of all, I'm really excited to see this kind of cross-pollination within DOE. It's really needed

for this, as you just described.

I wanted to talk a little bit about the element of speed and pace, and the need to look forward. A lot of what we've been talking about in this body over the last several meetings and our subcommittee work since then is how quickly things are moving and changing, and the ability to get a good handle on the kinds of transitions that we're facing.

You've mentioned a plausible future. So, I'm assuming -- and I've talked with David earlier -- that scenario planning is in your bag of tricks for accomplishing these tricks -- these tasks, rather.

So, I'm just curious about that process. Are you planning to do scenario development by regions? As Pat was saying, you know, different resources, different constructs, different regulatory frameworks, different parts of the country, in order to sort of look ahead and not get too stuck on how we just bolt things onto the existing paradigm, but really sort of look to

where we're really going as we get this more flexible, more diverse energy system and grid developed.

It's going to change a lot from where we are, and we have to be able to think beyond what we're stuck with right now. We need to get the most out of what we have, for sure, but we can't be stuck in thinking that, you know, everything's got to conform to that construct.

MR. PARKS: I think that's a really important point. The degree that we do that has not been established yet, because we hope to borrow from some of the existing exercises that are going on -- for example, the smart grid investments that we made and that interconnects into what they're doing is the platform that we're kind of using as a basis for how to start on these things.

So, where we see gaps and things to jump in -- but I think as you see more people doing it -- whether it's WEC, or an Eastern Interconnector, or at the state level -- we hope to borrow from

that, and not have to reinvent everything as we go along.

But we do think it's really key to think about, as you've said -- you know, we're laying out a five-year plan, but there are things that we're doing that are going to create the foundations for 10 and even 20 years out, when it comes to some of the platforms. Basic computational ability is -- really, the intersection of some of the things from RPE and science aren't going to happen in that five-year period.

So, we're cognizant of that. We're trying to walk a balance of, how do you move enough of the space, you know, in the shorter term, while not shutting off the options as much as possible for where that future's taking us?

CHAIRMAN COWART: All right. I think that's the last word. Thank you very much.

MR. PARKS: Thank you, Richard. Just -- we will follow up. We will try to give you some specific requests, and see where that takes us.

Thank you very much.

CHAIRMAN COWART: All right, thank you. We're ready for our afternoon break, which should be about 15 minutes, so we're going to resume at 3:00.

(Recess)

CHAIRMAN COWART: All right, thank you. We're dealing with a change in the schedule for the afternoon. We're informed that Jeffrey Taft, from Pacific Northwest National Lab, who is going to speak on grid modernization or grid architecture, is dealing with the fact that his plane was diverted to Richmond. So, I think we're going to have to hear from him tomorrow morning.

MR. GELLINGS: Well, we've got a substitute arranged, Richard. So, let's pretend that that section is last, and we'll see how the afternoon plays out. How's that?

All right. But you do have to -- you owe me recompense for having screwed up the schedule here. So --

CHAIRMAN COWART: I'll figure out how to

pay, okay?

MR. GELLINGS: So, the subject is grid modernization, and I have to say it's been the subject of conversation among this body for the four years or so that I have been associated with it -- only it had different labels, different names, and I'm kind of glad we've morphed into this one, although we haven't given up on all the others yet.

So, anyway, rather than try to be bold and suffer inserts from Robert Curry by trying to define any of this, I'll just say that there are a number of ways -- some of which we've touched on already -- that we can consider modernizing the grid in order to enable all of the functionality that's been inferred.

And what we're going to do now is get some real experts -- not me or Bob -- to talk about what those might be. There are four pieces that we envisioned. My objective was to introduce all four pieces and the participants at once.

We had budgeted in the order of 35

minutes in total for each segment. The suggestion I gave to the individual speakers was to talk for 20, get a few clarifying questions out, and then later on, we'll all get together up here, reconvene, and have a general dialogue. And they've all agreed to follow that -- which then means that gives me license to be disruptive if they tend to go over time.

So, first of all, the first segment will be on the overview of the DOE Office of Technology Transitions, in particular as it relates to the issues of grid modernization. Steven McMaster, Deputy Director of the DOE Office of Technology Transitions -- brand new, more or less, in that role -- is going to join us for that, and he has been associated with the issues of transitioning emerging energy technologies through a variety of experiences he's had as previously, for example, the Director of Technology Development at the Idaho National Laboratory.

Each of the speakers has a much longer bio. I accept the risk of selecting only a

sentence or two out of it -- so my apologies to all of you, as well as to them, for my selectivity.

The second segment will be back to ARPA-E and the Electricity Research Program there, with a number of technologies that are directly related to grid modernization. Timothy Heidel is a Program Director for Advanced Research Projects Agency Energy -- ARPA-E -- and he's going to talk about development of new approaches for controlling and optimizing transmission and delivery of electric power. He's best known for being the Research Director for MIT's 2011 Future of the Electric Grid Study, which I was part of -- and I think probably a few others here were.

Then there's the issue of making the distribution grid more open, efficient, and resilient. Paul De Martini, who's Managing Director of Newport Consulting Group, is going to talk to us about that. He currently provides management consulting regarding customer-centric business models, integration of distributed energy

resources, and grid modernization. He was previously Chief Technology and Strategy Officer for Cisco, Vice President of Advanced Technology at Southern California Edison, and he actually led ICS International Energy Strategy Practice, and he has become kind of a center place in these discussions about what the role of the distribution system will be in the future. And I know that you'll find that interesting.

Should we have the opportunity to have Jeffrey Taft join us this afternoon, he will be talking generally about grid architecture, and maybe I'll say a word or two about him or his replacement, who has already been identified, but I won't go through that just now.

So, having said all that, let me turn, if you will allow me, to Steven McMaster. Steven, please join us. We appreciate your coming.

MR. MEYER: Thank you. Well, it's nice to be here. I'm Steve McMaster, from the newly-created Office of Technology Transitions at the Department of Energy -- appreciate the

introduction. This is my first time attending a meeting with this group.

I'm also a newcomer to Washington, D.C. I came about two and a half weeks ago from the beautiful state of Idaho. So, if we want to talk about transitions, I could point out that I'm in the middle of one. And it's been a good transition thus far.

I want to give you just a little bit more background about me, so that you know for absolute certainty that I'm not an expert on grid technologies. But I may have some expertise that might help, as we talk about this topic of transitions.

My background before coming to the Department of Energy a couple of weeks ago was to be the Director of Tech Deployment at the Idaho National Laboratory. That was a position I was in for about five years. And, as you know, the Idaho National Lab is primarily a nuclear laboratory, but it also has multi-program mission space, including a lot in the EERE space -- quite a bit

of work that is relevant to the whole idea of grid modernization.

Before being at the Idaho National Lab, however, I was in the life sciences. I did tech transfer and business development for over a decade at the Mayo Clinic in Rochester, Minnesota. Why do I bring that up?

Life science technologies can be very complex. Introducing those into commercial use can be very complex. Think about modern medicine and some of the modern technologies that we all benefit from, and what a challenge it is to move something from benchtop to the patient's bedside.

And so I've seen some of that in practical application. I've been a part of some of that -- had the good fortune of working early on in my career with a new technology that allowed people to have their cancer screening done for colons virtually, rather than using an endoscope. And so for any of us who are over 50, that's probably a technology that's very interesting to us, right? Imagine getting a colon screening

without the prep. And so that's one of the technologies I was able to work with.

And I also was able to work with a really interesting suite of 3D visualization software tools developed by Mayo Clinic. It's a very robust suite of tools that allows you to visualize, using a variety of 3D image sets -- coming from CT scans, from MR scans, from fluoroscopy, whatever the modality -- and bringing those all together in a place that allows you to use them for planning a medical procedure.

A real great example of how that tool is useful comes in the case of when they are trying to separate conjoined twins. Prior to that kind of technology, the odds of separating successfully conjoined twins is pretty iffy. But with that tool, you can map out where the blood flow is, where each of the organs are, and how to really perform that procedure in an efficient manner.

So, a great technology -- very complicated, very hard to get to the marketplace, for a lot of reasons. You've got to validate it,

and make sure it works before you actually use it on people.

So, I'm going to talk today about this new office that I'm now a part of, and I will see if I've got the right -- okay. So, this is a new office, as I mentioned. This is an overview of what the mission -- the what, the how, and the why are of this new office.

At present, we have an Acting Director of the office, and that is Jetta Wong. She's been a member of the EERE tech-to-market initiatives, so she's very experienced understanding how to move promising programs for in the EERE space.

The person who helped stand it up was Ellen Williams, who is now the Director of ARPA-E. And so she had a strong vision for how this office might look, and how it might take shape.

And, really, at its core, the mission is to expand the commercial impact of DOE's $10-billion portfolio of RD&D activities over the short, medium, and long term.

So, it's not a quick fix. There aren't

easy solutions on how to quickly move technologies out, but it's trying to develop that vision of, how do we do that in a coordinated fashion? And I think that's going to be something that's important as we talk about grid modernization.

It's a functional unit that will perform a coordinating and oversight role for the Department's multiple tech transfer-type activities. The term "technology transitions" was chosen deliberately, because it's broader than "technology transfer." There's a recognition that early-stage technologies need to go through a number of transformations as they're handed from basic, to applied, to demonstration scale, in order to move effectively forward towards commercialization.

And one of the challenges that we face is -- I think the Department of Energy faces is, how do you know how best to measure where we're doing that effectively, and where we can improve, and where we can focus our energy so we get the most outcome for the dollar of research invested?

The OTT's going to work to develop and understand the delivery of that strategic vision and the goals for technology commercialization, engage with business and industrial sectors, in order to understand what the stakeholders' interests are, and how we can best fashion those programs so that they work. And, you know, again, the goal is to derive the maximum benefit, the maximum impact.

So, here's some of the questions we're starting to hear already: So, how will this office work within the Department and prioritize areas where technology transfer can occur? So, being a newcomer to DOE, I thought it'd be easy to get those answers together, and prepare them for release to the public, right?

Well, I'm learning a lot of things. Releasing any information is a different experience within the government. And I'm not being critical of it; it's just a different experience. And so I have what has now been redlined about 14 times the official response to

those questions. I'm not going to read those to you, but just know that there's a process that I'm learning about for, how do you actually answer questions? And how do you do so in a way that doesn't offend somebody too badly? I don't think you can answer anything without maybe raising somebody's attention, but that's good.

So, the first question -- how will the office work? You know, we're going to have a coordinating function. We are DOE, Department-wide. We will work with the program offices, and really understand how their research outputs fit into this overall technology commercialization space.

I used an example in talking -- a side conversation earlier -- of how software moves from early- stage development to ultimate product deployment and commercialization. Early in that process, you have to make a decision: Are we going to go open-source software, or are we going to go proprietary software? And you need to make that decision sooner rather than later, before you

get your developers all spun up, the product all hardened and ready to go, and then only to discover, oops, we can't go out with it, because we used proprietary software from somebody else, or we gave away the rights, or we had no control over the software anymore.

Those are decisions that need to take place earlier rather than later, and our question is, how is this office going to work with the programs and the other research organizations to figure out the best way to raise those questions earlier rather than later in the process?

So, what are the biggest challenges the Department faces? I was a part of a group that's known as the Technology Transfer Working Group prior to coming here. I was the Chair of that group for the year before. I think that's kind of how I found out about this opportunity. And in the course of those discussions, that has representatives from all of the national laboratories, and those types of issues and challenges are regularly discussed, and best

practices are reviewed and identified in an effort to come up with solutions. How do we then face those big challenges?

And one of the biggest challenges is, how do you coordinate what's going on within the various programs and areas that are funded by DOE? There's the complexity of the organization. There's the complexity of the research, and there's the complexity of the human factor, which enters in. And, as a result, sometimes you have variability within the system. You can get treated differently, depending on which lab, which field office, which pocket of the research enterprise you engage with.

And our challenge is to figure out how to ensure a little bit more uniformity -- not that it's going to be centralized, but just the best practices percolate to the top for the benefit of the whole.

Are there additional organizational or funding changes that should be made? And my joking answer to that question is yes. The extent

of that, though, is something that we need to think about carefully. We don't know what those changes may be. We recognize there may be opportunities to do things better, but we want to make sure that we're really meeting Congressional and stakeholder expectations when it comes to an improved technology transfer and commercialization performance.

We're currently developing a strategic vision and execution plan for the Department's technology transition activities, which will be published in the form of the Fiscal Year 2015 Technology Transfer Execution Plan. We're also working to develop a Secretarial Policy Statement.

So, those will be some of the ways that we hope to address those questions.

This is the reporting structure for the new office. And it's an interesting structure in the fact that it's going to be housed in the Office of the Undersecretary. Dr. Orr spoke earlier. It will be housed within his organization. That's to give it the breadth and

the exposure to all of the different Department offices, but it will also reach out and engage with NNSA, EM, and the other agencies that I've got listed under the engagement block. The intent there is to have this be a Department-wide functional office.

Now one of the statutory requirements that has emerged is that the Secretary is to appoint a Technology Transfer Coordinator. And the Director of this office will also serve that role, and so there's a direct report to the Secretary in the capacity as Technology Transfer Coordinator.

And just to talk briefly about that -- these are the requirements for the Tech Transfer Coordinator that were established back in 2005 -- some of the activity that that position needs to monitor and advise the Secretary on -- and the importance of having that position within the Department of Energy.

This is a visual to kind of convey that it's more than just technology transfer that we're

going to be focusing on. Technology transfer happens near the end of this spectrum, the right end of the spectrum. Most commonly, people think about licensing, and patents, and intellectual property, and sort of the transactional events that occur in connection with those types of things.

But like I said, we need to go back and talk about earlier stages in that process. What happens when you move something from the early stage off the lab bench into the hands of an applied lab -- or it moves from a university into the hands of a business? How do we help facilitate those transitions, those handoffs, so that they happen in an efficient and hopefully effective manner?

And, ultimately, the goal, then, is high-impact commercialization activities. Let's get these things out, and be a part of the new modern grid effort.

And these are the responsibilities -- just (inaudible) what the office is going to take

on. There's -- you can read those for yourself, but there's oversight management coordination, communications, telling the story. There are a lot of wonderful things going on within the DOE-funded research programs, and perhaps we haven't been as effective in communicating those stories. There are examples of, you know, technologies that have been worked on for decades within the Department of Energy programs that are just now starting to feel their impacts in the commercialized world. And in some cases, there's secondary innovations that have spun off of those early innovations made within national laboratories.

So, we'll do some of the statutorily-mandated stuff and the reports. We'll also be doing data collection and analysis to help inform what are best practices and things going forward.

We have to set up a budget. Our budget will have two parts. The first part's boring; it's just the operational part. You know, you've

got to have just enough people to carry the water.

The second part's the exciting part, and that is something that's also required by statute -- the same statute that calls for the Tech Transfer Coordinator, and that is a fund called the Technology Commercialization Fund. And that's to provide matching funds with private partners to promote promising energy technologies for commercial purposes. We're about to figure out how to implement that. That's not going to happen in FY15, but our goal is to have implementation of that new Technology Commercialization Fund start in 2016.

This is the statute that describes it. There's some pretty good lawyer language in there. We're not exactly sure what it all means, but, in essence, it tells us that we have a certain percentage of the applied energy research and development budget, and we need to use that in connection with matching funds from private partners to move forward the most promising technologies. We will look to people like

yourselves to help us make sure we are doing that appropriately.

And, you know, again, the future is that we will be implementing that. We're estimating that that 0.9 percent will translate into about $20 million. So, you know, it'll be not a huge amount of money, I'm learning, in Washington, D.C. circles, but still significant resources that should really help mature promising technologies.

And then we'll be doing a bunch of reports. These are also required by statute. There's a series of data that are collected every year for the NIST Report, and then the Annual Tech Transfer and Partnering Report, and the Tech Transfer Execution Plan. This is sort of our tentative schedule for those major deliverables -- again, it's fairly aggressive. There's about a handful of us in the office right now, but we're underway, and we're off and running. We're open for business. We're excited for the challenge that it presents.

Dr. Orr mentioned some cross-cutting

programs. These are some examples of some of those. I'm not going to dwell on those. And then, also, we're following up on a pilot. It was established a couple years. It's running to the end of October 2017, which is intended to make interactions between labs and industry a little more efficient, a little more effective, and address some of the agreement concerns that exist there.

And then we're also putting together a success stories piece that will help us tell the story of the many good things that are going on within the various university collaborations and national lab collaborations that DOE is a part of.

And, as I mentioned, we're doing some data calls. The 2014 pilot data call is complete. We're analyzing the data now. We think it's going to be -- it'll help us tell the story of where the resources are going, how they're being effectively used, and where there's opportunities for, you know, getting even better at what we're doing.

With that, I don't know if that was

quite as short as I was hoped for, but I will leave some time for questions now -- or we can wait until after -- whatever you prefer.

CHAIRMAN COWART: Clark, as you wish.

MR. GELLINGS: That was very helpful.

MR. MEYER: Any questions for me? Paul?

MR. CENTOLELLA: Two questions. One is, I'm curious to what extent you're looking to resources outside of DOE to partner with you in technology transfer. I noticed you mentioned SBIR funds up there. There are applications of some of these technologies in DOD and elsewhere. And one of the things that we know happens is that a lot of technologies get developed in the lab through ARPA-E and other early programs, and have a hard time making it actually into the commercial marketplace. And I'm wondering to what extent you're leveraging other kinds of resources beyond the $20 million to try to make some of that happen.

MR. MEYER: And that's a great question, and that's -- you've described the challenge very

well. There are a lot of nascent technologies that come out of the research programs that need a little oomph to get them over several of the valleys of death that we've identified, in terms of moving promising technologies forward.

I'm aware that there's currently a program -- it's a pilot -- that DOE's running, with its SBIR/STTR program, where they actually use national lab technologies, and they roll those into the calls that the SBIR program puts out. So, then private companies can come in and say, "Yeah, we'll take that idea forward, and we'll use some of our own funds, and we'll use SBIR funding to do it."

How we use the Tech Commercialization Fund to match with that kind of effort or other efforts from the investment community, we don't know yet, but we're going to be looking for as many possible combinations as we can, and we'll probably -- my vision is that we may have to mix that up a little bit, try a couple of different variations during the initial year, and then see

what works best.

MR. CENTOLELLA: My other question comes from -- I was fascinated by the fact that you had been at the Mayo Clinic and had this medical background.

MR. MEYER: Yeah.

MR. CENTOLELLA: And one of the things that is interesting from the medical field is this emergence of translational R&D -- being able to go to end users of technology, see how they're going to use it, and then pull that back into the R&D space. And I'm wondering if you see an application of that (inaudible) DOE.

MR. MEYER: Certainly, yeah. I think there'd be, certainly, some wonderful opportunities. And I don't know how the best way to gather that kind of stakeholder or user data is going to be within the energy field or in grid modernization, but I can see opportunities for going out to the potential customers and users of the new modern grid models of the future, and asking for their feedback realtime, to say, "Are

we solving the right problems?"

It's a customer discovery model. In, you know, the world of startups, they call it "lean launch." You've got to go out and talk to your customers, and really find out what they want. With patients, you've got to find out, you know, what's the art of the possible? And then, from there, bring it back to reality, and make sure you're not breaking any laws of physics.

MR. CENTOLELLA: Those are the laws lawyers can't get you out of.

MR. MEYER: Other questions?

MR. GELLINGS: We'll get a chance to talk more (inaudible) discussion.

MR. MEYER: Great. Thank you.

MR. GELLINGS: Thank you for taking the time -- appreciate it very much.

Tim Heidel, please.

MR. HEIDEL: Well, I'd like to thank the committee for the invitation to speak today. My name is Tim Heidel. I'm a Program Director at ARPA-E.

I'd like to give you, over the next 20 minutes or so, just an introduction to some of the programs we've run over the last couple of years related to electricity, and then talk a little bit about, how do we find a way to get those technologies through to widespread adoption?

So, just in case you're unaware, we're a fairly new agency. We were stood up about six years ago, modeled after DARPA in the DOD space. And we were given the mission by Congress to ensure America's national security, economic security, energy security, and to maintain technological competitiveness through the means of catalyzing and supporting the development of transformational energy technologies specifically focused on achieving these three objectives: Reducing imports, improving efficiency, and reducing emissions.

Now we, as an agency, work across the entire energy landscape -- everything from bio fuels, to batteries, to grid optimization. And I'm going to give you a little eye chart now, just

to talk about some of the electricity- related programs that we've run over the last couple years.

So, let's take our nominal grid that's shown here, with many of the components sketched out in comic form, and let me run through some of the programs we've launched over the last six years related to electricity. I'm going to apologize in advance; we use acronyms for everything, and I don't actually know many of the words behind the acronyms. So, let me take you through it, and you can always look them up.

First, I'll start with two programs that I also manage, aside from my grid-related responsibilities, which is ADEPT and SWITCHES. These are both power electronics programs seeking to enhance the energy efficiency of power conversion for a wide range of applications, from LEDs, to automotive applications, to power flow controllers.

We've also had a program, BEET-IT, focused on air- conditioning technologies and

alternatives to cooling buildings. We had a program focused on rare earth magnets for industrial applications. Light metal refining technologies -- certainly a technology that uses a tremendous amount of electricity in the production of light metals.

We've had programs focused on solar technologies, including a solar ADEPT program, which was solar inverters- focused, as well as a program that we call FOCUS, which is seeking to combine the benefits and the best attributes of both thermal, solar, as well as photovoltaics.

We're in the process now of launching a program focused on power plant cooling technologies and reducing the water use in conventional power plants. And then we've had a series of programs launched in just the last year -- MOSAIC, GEN-SET, and REBELS -- all focusing on different flavors of distributed generation, from small engines, to fuel cells, to photovoltaic applications.

And then, finally, the program that

really, in my mind, ties all of these together is a program that we launched three and a half years ago called GENI. It stands for the Green Electricity Network Integration Program. And this has been one of the large programs that I've managed over the last three years at ARPA-E, and I'll step you through our motivation for this program in particular, because it has the most relevance to the meeting today.

We launched the program in anticipation of plots looking like this. You can see on the horizon that both solar, and wind, and other resources are starting to increase their penetration dramatically and quickly, and, of course, these resources have characteristics unlike anything that we've really dealt with in the past, where they have definite seasonal variation, but there's substantial short- term uncertainty and variability.

This is a plot for five different years of solar radiation, with hours across the horizontal and days of the year on the vertical.

And you can see, certainly, that you certainly do see longer days and brighter sun in the summertime, but then you see all of these black lines. And those are not artifacts of the image; those are actually just simply cloudy days. And so we need to figure out how to deal with that.

You could also look at this elsewhere, and various organizations have posted projections for how this might impact the actual operations of the grid. I certainly don't need to motivate that here today. Really, what makes this an interesting and a challenging problem is that what we're doing is, we're layering yet another new requirement on a series of old requirements. And you don't have the luxury of giving up any of those previous requirements; you are simply making the problem harder.

And so we started way back in the 1930s, and we said, "What do we want from the grid? What's our goal of operating the electric power system?" And we said, "It needs to be affordable. It needs to be safe. And it needs to be

accessible to all." And, eventually, we realized just how important electricity was to the economy, and we said, "Well, it has to be reliable, so let's seek out ways of improving the reliability of that system."

Eventually, starting in the 1970s and carrying forward all the way today, there's a real priority to make things cleaner and to reduce emissions, for a wide variety of reasons -- including climate change. More recently, we started to really focus on, okay, let's make it secure. Let's make it more resilient.

And then, finally, what's emerging today is, we need to make it more flexible to respond to increasing dynamics, uncertainty, and variability in the resources that are connected to the system.

And so when we launched the GENI Program, it was that flexibility attribute that we were very focused on. We said, "How do we make the system more flexible?"

Now ARPA-E also looks very specifically for white spaces that are underinvested by other

organizations, other parts of the government, as well as the private sector. So, our goal is not to take the word "flexibility" and say, "Let's do everything we possibly can related to flexibility," but, rather, "Let's look for opportunities that are being underexploited by others."

And so where we landed, after talking to a lot of folks in industry, academia, other parts of governments, and lots of conversations inside the DOE, as we said, "Well, there's a big opportunity for ARPA-E," specifically related to what I'm going to call "network flexibility," which is thinking about those assets that exist and sit on the grid that we actually could control if we wanted to, if we had new technology.

Historically, you built your lines, you built your transformers, and, largely, they were fixed. You weren't really going to dispatch those in realtime. Maybe you make seasonal changes. Maybe you make changes for emergency situations, but it's not a core part of everyday operations --

is to think about what your network should be, in addition to how you're going to operate generators and other resources.

So, what technologies could give you additional network flexibility? Well, first, there's power flow controllers -- both AC power flow controllers, as well as HVDC systems. And I have an example of one of those AC power flow controllers in a couple slides.

There's a concept of transmission topology optimization, which has become a lot more popular over the last couple years, where you're actually using algorithms to tell you when, and how, and where can I take transmission lines out of service to ease congestion, while not having a negative impact on reliability?

And then, finally, if you had lots of energy storage that was low-cost, you could think about algorithms to actually tell you, how should I optimally dispatch, and use, and schedule all of those energy storage resources?

And then, of course, there's a huge

opportunity that we've only scratched the surface on here, but I know that many people in the room are working on this elsewhere -- on scheduling, and leveraging, and aggregating responsive demand for system operations, to make the system effectively more flexible.

So, we launched the GENI program. I mentioned this a little while ago. We launched it in late 2011. All of ARPA-E's programs have roughly a three to four-year lifetime. So, this program's actually coming to a close this year. About half of the projects have already ended, and the rest of them are scheduled to end within the next year or so.

This program started with 15 projects, and was roughly $40 million of total investment. And we broke it into two separate categories of innovations. One was this area of power flow controllers, and one was focusing on new methods and approaches to grid optimization.

So, let me take the power flow control category first. Historically, power flow control

devices have typically been manually dispatched to correct local problems. And where people have tried to establish much more flexible power electronics-based power flow controllers, high costs and low reliability are often cited as early problems with those systems that limited their more widespread adoption.

And so we said, "Well, can we rethink the hardware that's used in those circumstances?" So, can we find power flow control hardware that uses what are called fractionally-rated converters -- where the ratings of the actual power electronics, the transistors, are not tied to the total amount of power flowing through a line, but are only some fraction of that, but still give you the ability to control power flow.

Can we think of more modular and manufacturable designs, so that you could think about actually building thousands of these individual power electronic building blocks in a factory, and then deploying them in the field as if it was just an installation of a standard piece

of equipment, as opposed to thinking about these installations as major capital construction projects that take multiple years, and are one-off designs that are custom?

And then, finally, to mitigate some of the early reliability problems, can we find designs -- this was an absolute requirement of ours upfront -- we were requiring designs of these equipment and the hardware that would have failed normal designs, such that if and when that device failed, it would leave you no worse off than you would've been without the device.

Of course, it's not all in the hardware; you also have to think about new software that exploit the advances in the hardware. And new algorithms are going to be necessary in order to actually exploit large numbers of these devices, should they become cost-effective.

In terms of how you actually do it, this is our way of categorizing how you actually control power flows. I mentioned topology switching and line switching earlier. That's

certainly one method of impacting the way that power distributes over your network by removing lines. The simplest way to think about this is that, as you all know, power flows are governed by Kirchhoff's Laws. If you change the impedances of the network or you change the network itself, the power flows change.

Now, obviously, that's a very complex process, and we need to be able to actually calculate what the impact of that line-switch action is going to be on overall power flows, and that's why we need sets of complex algorithms -- not sort of a blunt object to simply remove lines in and out of service, making a binary decision; you'd much more prefer continuous controllability. And that's what these other types of devices give you.

So, certainly, you can connect back-to-back HVDC systems today, and you can get some degree of controllability. HVDC systems are some of the most controllable we know.

You can also do this through

variable-series voltage injection, as well as variable-series reactance insertion. And I will give you an example of that in three slides.

On the optimization side, we recognize that, first, existing grid optimization tools do not explicitly account for variability and uncertainty, and there's an emerging need to coordinate large numbers of distributed resources. We've only scratched the surface on that; we're currently in the process of launching a new program that's very focused on that second bullet. And so we will share results in another three years from now in that area.

There are also recent advances that enable more robust, reliable control of the grid, despite all of the physical realistic limitations such as the limits of what our state estimators can do, based on finite numbers of sensors and problems with models, which will always be there. Incomplete and imperfect information flow, constrained computational resources, inherent uncertainties in anything that is a

market-mediated transaction, of course, and then physical constraints to control.

And so we put that statement to the community. We said, "We think there are these advances, but they have to be subject to these limits, so come back to us with proposals on what the technology opportunities you think are that could actually give us a far more efficient and far more reliable optimization of grid resources."

We have a whole basket of different projects in the program that we funded, trying to build a toolkit, as Bill said earlier, of different approaches that'll be good and useful for different scenarios. We've had several teams working on distributed optimization. To what degree can you distribute the control and optimization of the grid? I've had teams working on improving forecasting and dispatch of demand. I have an example in a couple slides.

We have teams working on faster voltage and transient stability calculations, AC-optimal power flow algorithms, transmission switching,

stochastic optimization specifically for unit commitment applications, and then, of course, energy storage optimization.

So, unfortunately, I don't have time today to go into all of these projects and talk about each one of them individually, but I will go through just a couple examples, to give you a flavor of it.

In total, here's a snapshot of the overall program by lead organization, and I break the program into five different areas that we've funded -- from power flow control hardware, to HVDC components, to topology control, various approaches to optimizing the power system in new ways. And then we had two projects that were focusing on, how can we best utilize new emerging cloud computing, as well as big data tools to support grid operations?

This only tells part of the story, though, because every single one of these projects is a big team. One of the things we really emphasize at ARPA-E are these

vertically-integrated teams that go all the way from fundamental work, perhaps at a university or a national lab, through to actual commercial development with vendors, utilities, and ISOs.

For all of the software projects under this program, we had an absolute requirement from the beginning that any team developing new algorithms was required to test those algorithms on a large-scale utility or ISO-provided dataset, which required those teams to partner with a large number of organizations throughout the U.S.

So, let me just give you a couple examples -- and I'll check how I'm doing on time -- and all right. I'll start with one of the power flow control devices. And this is a concept that originated at Oak Ridge National Lab that said, can we use a very old concept, a magnetic amplifier, to give us the ability to control power flows? It's actually a relatively simple device, at least in concept.

This is just a transformer core that has a high- voltage transmission line wrapped as one

of the windings on this transformer. So, this is your high-voltage line that's carrying a certain current, and that's the line that I want to control the effective impedance of, in order to push or pull power around the network.

I then have a low-voltage -- what we're calling here a DC control circuit. And the purpose of the DC control circuit is to put the transformer into saturation on demand, and pull the effective impedance seen by the rest of the network due to that device either down or up.

And so here are actual results from the lab of a prototype of this device, with the DC control current here. And these are different AC set points for how much actual current's flowing through the high-voltage line at any given time. And you can see that with this particular prototype, they're able to control the impedance seen by the rest of the network from five ohms down to about two ohms, which is exactly what was desired for the field test of this device out at the Bonneville Power Administration, which -- and

we're going to be installing a device at BPA later this year, to start to actually field test this.

I'll give you a little bit more of a flavor of what this looks like. We started the project. When we first showed up the very first day, they had a prototype on the bench. It was using 12-volt batteries from Radio Shack, just to prove that this concept might work in theory. And we developed a lot of modeling tools to model exactly how this would work in much larger systems. We built a 480-volt prototype in 2012, which was followed up with an improved design in 2013.

Late last year, the team completed construction of the first phase of a high-voltage unit, and that is now going through factory testing as we speak, and they're preparing to build two additional units. All of those will be installed in the Pacific Northwest in BPA's territory later this year, for a one-year field trial.

SPX Transformers is the manufacturer for

the device, and they will eventually be the commercialization partner for this. The wonderful thing about this device as a power flow controller is that 98 percent of this is old technology. This looks like a transformer. This is just a transformer. All the technology related to that big box is a transformer. It's standard technology that SPX uses every single day.

There is a control box here on the side. So, we have a -- believe it's a 50-kilowatt inverter on the side there, so we need to work on the robustness and the reliability of that, and proving out that it's going to work. But when it comes down to the end of the day, it's actually a fairly low-power power electronics inverter for controlling a much larger amount of power around the network.

Talk about one other project -- this was with a small company out in California called AutoGrid. And AutoGrid basically said, "Can we use cloud-based systems and deploy a cloud-based software as a service platform for managing demand

response?"

When we started this program, the focus was on, if you had data on demand response controllability at the individual household level, you could actually target demand reductions based on network conditions in a highly granular nature. Imagine being able to dispatch demand reductions at an individual node in transmission -- or eventually, even at an individual node in distribution -- to overcome local congestion that might pop up for any given reason.

And, indeed, they've built a platform to be able to do exactly that. This project -- I apologize for all the words -- they were able to show that they can generate a forecast for demand response capability of individual customers of over a million customers every 10 minutes on a rolling basis. And they now have the platform that can actually send control signals to those customers, if and when that becomes desirable by the local utilities and ISOs.

For the moment, this company's been very

focused on simply managing all of the different rule sets that exist out there for demand response programs today. Many utilities are managing a dozen or more different demand response programs with different customers, different rule sets, and different requirements. And AutoGrid's deployed a platform that can help you manage that with no upfront capital costs, in terms of IT. It's literally a "flip the switch, and it's working tomorrow for you," as long as you have the data to provide.

I'm going to skip this project. This is another one I can talk about offline or in questions around transmission topology optimization and showing the benefits that transmission topology optimization might have. This project worked very closely with PJM to generate an estimate of benefits, both in today's system, with the congestion that PJM currently sees, where the conservative estimate the project ended up with was that just in realtime operations, this could save $100 million per year,

a software fix alone, and they studied high renewable situations where the goal was to reduce curtailment of renewables due to added congestion, since the power flows that were occurring on the network were not those that had been planned to occur when all of the planning studies and the installations were done. So, that gives you a flavor of those.

Let me just briefly talk about a new program that we're launching this year. We launched a funding opportunity announcement earlier this spring. You can go onto our website, and you can find this. The concept paper deadline has now passed, and so the opportunity to actually apply for this funding has now passed. But you can go see what we're intending to do.

This program's being launched by a colleague of mine. And the goal of it is to enhance the reliability of the grid under very high penetration renewable scenarios, through utilization of the flexibility inherent in demand. And what they've focused the project categories,

as well as the project metrics, on is actually proving that you can develop control algorithms and control architectures that can allow you to achieve the provision of ancillary services from distributed resources. And she's trying to be as broad as she possibly can when she uses the term "distributed resources" to mean storage, demand response, as well as photovoltaic inverters, and others.

If you could do this, you suddenly make the system far more flexible, especially under those scenarios where you have very high instantaneous renewable penetrations, and you don't have a lot of the traditional flexible generation operating.

That program, we will make funding decisions on later this year, and it'll again be a roughly three-year program. And we're anticipating putting about $30 million of investment into that area.

Now I have one more topic that I want to cover before I stop. And this is probably the one

that I would like to see more discussion on after this meeting, and I'd love to take questions -- is, what happens in month 37 of our projects?

Most of our projects are 36 months longer. Our programs are built to be about three years long. And there's no intention, from ARPA-E's perspective, to continue -- or there's no plan to continue investing in those areas. We're seeking to identify areas where there's a white space opportunity for us that have too-high technical risk for the private sector or other parts of government to invest.

We will then spend three years reducing that technical risk (inaudible) our goal is to reduce that technical risk sufficiently that the private sector will jump in and start to invest, and will carry the technology forward from there.

This is a particularly difficult sector to see that happen in three years with $30 million. And so one of the things that, honestly, we have not solved yet is to identify, how do we carry these technologies forward after ARPA-E?

So, we do some of this work during the projects. We have a whole tech-to-market team at ARPA-A -- that their premise is essentially this slide -- that big ideas, bold ideas, even good ideas are often not alone enough to actually have an impact on the world. And ARPA-E's mission is to have an impact on the world.

Often, you run into, well, the team just didn't have the right skills; brilliant technically, but they just didn't have the right commercial orientation or commercial focus. They weren't able to identify the unique short-term value to an actual customer. We know the technology has enormous value in the long term, but how do we have it survive until then? We need to find some early market opportunity and early value to carry it forward. And sometimes, it comes down to just simply poor implementation.

So, with ARPA-E's tech-to-market team, we work very hard with teams -- working them through how to do basic techno-economic analyses, how to engage with a broad range of stakeholders

to learn both what's the potential value of their technology, as well as to build their own team for the actual commercialization of the technology that often happens through ARPA-E, and then through various other skills development and resource development activities with our teams, to try and align their idea with a sense of its value, with the right team, with implementation, so that they can have an impact on the world.

And we would love to see some of these technologies. And some of them do take off immediately after ARPA-E, and are having a market impact today. We have several examples of that.

But for most technologies -- you've already heard this today -- there exists many valleys of death. And ARPA- E exists at the early stage, more on the fundamental level, where we're trying to take a fundamental idea that has come out of the scientific community and the basic sciences office, carry it through to the proof of concept that something just might work and might be real.

But as I mentioned earlier, there's an enormous amount of work that has to be done after that proof of concept, before something is self-sustaining in the commercial world. And I don't think we have a great answer yet in this particular sector for how to get that done, especially today, with as little venture capital is out there for hardware in general -- and for energy hardware in particular.

So, I think I will leave with that. It requires a tremendous amount of thinking to figure out, how do we bridge those later valleys of death, to see the impact that we want to see with these technologies?

I will leave at that. Thank you. I will take a couple questions if people have them.

CHAIRMAN COWART: Chris?

MR. GELLINGS: Your challenge is going to be (inaudible).

MR. SHELTON: To your last question --

MR. HEIDEL: Yes.

MR. SHELTON: I think you need sort of

intractable problems. So, you know, you all have done a great job defining conceptual need and directional need, and you're targeting your programs toward that, and I applaud that. And I think you need to do that.

But the thing that would help you get through the prototype valley of death is a clearly-defined, present need by somebody. And then the market will put money behind that. The customer themselves with the problem will do the investment, because the risk/reward is clear. So, it's a beachhead. It's early market. It's the same concept, but it's not just saying it's an early market; it's literally a single customer with one problem. That can, I think, really make a difference for some of these things.

MR. HEIDEL: (inaudible) other questions? Yes?

MS. ZIBELMAN: I have a comment, actually. Your last comment about the lack of capital -- I actually don't think that's the problem. I think there's plenty of capital.

What's the challenge is -- and I think, you know, I'm kind of curious how we're going to link the technology transfer with ARPA-E -- is actually the business models that we need to create in the industry so the capital can be deployed.

I think our biggest issue has been getting out of pilot phase and getting into, frankly, just systemic changes in the industry.

So, I think, you know, the other aspects that we're working on in this group around advancements in the business models are going to be critical for this.

MR. HEIDEL: Yeah, I absolutely agree with that 100 percent. We have had several teams very successfully find utilities to pilot projects with. There are very few utilities today that are willing to take serial number one, but there are some. Those teams have then really struggled, though, to turn those pilots into commercial deployments at scale. Unfortunately, a lot of the teams had heard feedback of, go find somebody else, deploy your first 100 units, and then come

talk to me in five years.

And, unfortunately, in the back of the mind of -- if it's a startup in particular -- the back of the mind of the startup of that point is saying, well, I won't be here in five years with that answer.

So, I think you're right; it is, in part, a big- business model question.

MR. GELLINGS: Others?

MR. CURRY: Just to follow up on Audrey's point -- the arbiter of whether it's a good investment or not is often the regulatory agency that the utility reports to, rather than only the evaluators from the utility who's the prospective customer.

There are some resources around this table who would be delighted, I think, to help introduce a concept at the regulatory level that you need it introduced at -- at a state level -- because there is a rule of thumb: The only good thing about being a former Commissioner is, you can always get a meeting with a sitting

Commissioner, you know. And so that's either good news or bad news, but it's the truth.

MS. ZIBELMAN: Depending on (inaudible).

MR. CURRY: No, I think you can really pull it off. So, keep that in mind when you get the pushback. Is the pushback coming from someone who's worried about a prudence investigation, or his budget isn't sufficient to enable this. And if you can take the aura of the DOE, and bring it in, and work for the government -- we're here to help you, et cetera -- that might enhance the ability to get to serial number one.

MR. HEIDEL: I appreciate that. Thank you.

CHAIRMAN COWART: Carlos?

MR. COE: You know, one of the questions as I look through your portfolio of projects is, you know, as you're looking at, okay, what's the next step for, you know, the technology or the other companies -- and, you know, the folks in the utility world, they're incredible conservative, you know, folks, right? So, they want to see

something that has 10-year history or, you know -- even not the first 100, but the first thousands, you know.

And I was curious how ARPA-E interfaces with the rest of DOE, to try to get more of those devices, you know, in the field.

MR. HEIDEL: Sure. So, I've been sitting on the grid tech team for the last couple of years, ever since arriving at DOE. And I think that's been the means by which we've had those conversations. It involves a lot of internal briefings and discussions around technologies that we've identified to say, hey, you know, I think this area of power flow controllers could be really important. And we're going to get it so far along, and then maybe there's an opportunity there for a follow-on program.

Now ARPA-E doesn't have any control, dictation, anything with other offices, right? So, we can make those recommendations. And I think, honestly, the other offices in DOE are hearing from a lot of different organizations that

are saying exactly that. And so they have to prioritize, to figure out, what opportunities are they going to try and go after?

And then, of course, they have to try and go get the money for that in an environment that is extraordinarily budget-constrained today. You know, I think there's been a lot of recognition around the Department that a lot of these technologies have a lot of value, are still in the early stage where there's likely a government role for continuing to fund them. It's very difficult to find funding for that today.

And so I think when I wake up in the morning, my goal is to go out and try and find a utility, or a vendor, or someone else with private money to invest in this beyond where we're going to take it.

But there's also a secondary role of working with the rest of the Department to find those opportunities.

Other comments or questions?

CHAIRMAN COWART: Yes, Jeff?

MR. MORRIS: Thank you. I think you kind of touched on this in the answer a second ago -- but a decade ago, I started an energy angel investment group, and it's almost the same problem. You know, when you get above $3 million, that's kind of out of the angel sphere. The biggest challenge is finding deal leads within the angel group.

And with these larger projects, when you're bringing them out -- when I talk with companies, they all want a piece of the action to get familiar with the technology, but no one wants the zero-one. And what's lacking is, really, project leads to put, you know, kind of -- the telecom industry, they always put these shell companies together to solve, you know, telecom engineering problems, so they can have nondisclosure agreements with each other, but get operating experience with something new in their system.

And that's just something that's lacking as a tool -- is to say, hey, it's not just finding

a pilot project; it's finding the partners. They're willing to put their money in, but no one wants, you know, the 51 percent. They all want, you know, 32 or 33.

MR. HEIDEL: Yeah. The one example I know of that happening related to this sector was with another company called Smart Wire Grid. It was another project in our portfolio. It was a technology that was originally invented at Georgia Tech in the early 2000s. It was 2003, or 2004, or so.

And they actually incubated that idea with a consortium of five or six utilities that each took an interest in the incubation of that technology. And they slowly kept pushing it up the hill, and kept pushing up the hill until they got to the point where it was mature enough for ARPA-E to pick it up in 2012, and take them to an actual ruggedized, tested field trial of the device in the field.

And so it was a little bit of a, hey, we had that. Everybody pays into this consortium and

the risk-sharing before ARPA-E's investment.

And I think what you're suggesting is, can we find a mechanism to do that post that investment, when the dollars are going to be even larger? And I haven't seen that successfully done yet, but I would love to see that happen.

MR. GELLINGS: Billy (inaudible).

MR. BALL: As one of the companies that was that early investor in Smart Wire Grid, maybe you need to ask the utilities before. Maybe it's, you know, trying to bring somebody in after. You know, I've got a product. I want you to -- obviously, you have a need for it. You know, I would say, spend more time on the frontend with the utilities to say, "What do you need?"

MR. GELLINGS: All right, we'll have more conversation yet later. Thank you.

We're going to change the schedule just a little bit. I already gave you a taste of that, and we're going to -- after Paul's done, we're going to have the panel discussion, and we'll follow up with our last speaker, who will be able

to join us in the morning.

Just a quick comment about this concept that you just touched on of collaboration -- that's been, actually, an EPRI mainstay, most of you might know. I mean, things like Marcy, and Inez, and whatever -- all the original six fax devices were all collaboratively funded -- not just by the host utility.

And the last big one of these, of course, was some of the carbon capture and sequestration -- again, Southern Company, but not just them -- some other utilities -- 31 or 32 utilities in all contributed. That's been a great model, but the industry's kind of tired of it -- and for a variety of reasons we could get into. But that is a way to get things done, and there is at least one institution that has had some success in doing it.

Paul, talk to us about distribution.

MR. HUDSON: Thanks, Clark. My presentation's going to talk quite a bit about what's happening in California, as we think about

a more distributed future there. But it is very relevant to, you know -- similar discussions are going on in New York, particularly Track One in New York, looking at the platform dimension, the operational dimensions, and the market design aspects. Those are very much part of the conversation in California -- and also starting to happen elsewhere in the United States.

You know, just as a starting point, certainly, we see a fundamental opportunity here to think differently about how the distribution system might play a role in not only providing, you know, in the traditional sense, electricity delivery, but, increasingly, in a number of places -- especially in California -- why we're starting to see fairly large amounts of distributed energy resources moving that system into more of a network structure has already been touched on.

And so part of the opportunity, as we think about it, is to better understand how this evolution may occur over time. As with all things, particularly at distribution, it's a very

local phenomenon. This evolution that is occurring in Hawaii or in California is happening at a different pace than other places around the U.S. So, what my comments are going to be reflective of -- a sequence that could happen over many different time periods, and even within a particular state, is going to happen very differently in different parts of that state, as we're seeing in California playing out.

As a starting point, what we've been thinking about is, how do we think about this evolution, and where in this evolutionary process do we need to think about shifting the way that we manage certain aspects -- the way we manage planing, the way we manage operations, the way we think about market opportunities, and so on, as we evolve?

In simple terms, we're currently largely across the U.S. in this grid modernization stage, you know, looking at enhancing the capabilities that exist in the system, both from an efficiency standpoint -- certainly, a lot of aging

infrastructure refresh going on in the distribution system -- and, certainly, we still have many smart grid investments that have still been, you know, started in the last decade; have continued on into this decade. And we're adding onto that, as well.

Certainly, from a customer engagement, many of the programs have started with a lot of the smart metering, got into, you know, providing cost management services, and helping customers understand their bills, and providing decision tools. And some of these are becoming very sophisticated in helping customers manage their energy costs.

But in some places, we're moving beyond that. And, certainly, in California, we've crossed the threshold into, you know, what I'm calling here stage two. Hawaii has already, you know, several years ago had crossed into stage two, where the level of DER adoption -- and I use the term "DER" very broadly. So, that includes distributed generation, you know, distributed

storage, electric vehicles, energy efficiency, demand response -- so a very broad definition, which is also the definition used in California.

And in that context, the adoption rates have gotten to a level where you need to start thinking differently about how you manage this system. And here are these questions and discussions around, how do we think about the role of utility and others in integrating distributed energy resources to create that integrated grid, as EPRI calls it? How do we think about optimizing that -- both in terms of, how do we send the right price signal so that DER -- you know, for those customers that adopt based on -- whether tariff design or other signals -- see that this is a good location or preferred location to adopt -- or specific programs and pricing or procurements to source distributed resources as part of a local dimension?

And then the other component to that is, so what is this additional platform of technology investments -- somebody had asked earlier today --

that would be required, over and above what is already being invested by the utilities across the U.S., to be able to do this integration? Some of which are the kinds of technologies that Tim was talking about a moment ago.

And then in this third stage, in this framework, is where we have a fairly significant level of distributed energy resources and, potentially, the possibility of peer- to-peer -- or at least commercial-entity-to-commercial-entity -- transactions across the distribution not having to go through the bulk power system.

We don't quite have that yet in the U.S. There's a few one-off examples of where this occurs in the U.S., but it's not really pervasive. But at some point, we may see that sort of a market-of-all.

So, really, in stage two, think about markets. And then stage to is many-to-one, the one being largely the utility or the bulk power system. In the distribution case, it's the utility that's buying those services. In stage

three, it's a many-to-many kind of relationship.

Now within that -- and I've kind of touched on this -- in California, as part of an effort -- a multi- stakeholder process called More than Smart, that was launched by now-President Michael Picker -- the President of the California Public Utility Commission -- prior, when he was in the Governor's Office, had come up with this idea that we need to start thinking beyond smart grids. So, you know, this idea of More than Smart.

And so we had a series of conversations in California over the last few years that led to a paper that laid out that we needed to start thinking about the sort of structural and process issues. If we're going to systematize the changes, and think about what we need to do in California, we need to sort of take a structured approach in thinking about how to tackle these challenges.

So, just going around sort of a lifecycle, starting with planning, then looking, obviously, at, what's the implication for how we

think about designing and building this infrastructure -- and using infrastructure very broadly? And that isn't just the utility infrastructure, but how do we leverage the infrastructure that third parties -- you know, the distributed-energy resource providers are putting in? Because they are also putting in an infrastructure around measurement, and communications, and some cloud-based technologies that can be thought about more holistically, in terms of how we think about this system -- certainly, from an operational standpoint, as Clark said.

I've been doing some work with Lorenzo Kristov at the Cal ISO, thinking about the evolution of the distribution system operator over time. And then what we called in California DER services, which New York calls animating markets -- but it's basically the same idea.

So, how do we start to recognize the value that distributed energy resources can provide, and how do we think about engaging,

incorporating them into part of the mix, and how we operate the system?

We started in the process, even for planning, this question of, what do we want the distribution grid to be? At the time we started this conversation, RMI's paper about grid defection, you know, was only a couple months old. And so there was this conversation we had last summer at Caltech with a lot of folks in California that are representative of utilities in California and other stakeholders in California, as well as national firms that are active across the U.S. in developing distributed-energy resources.

And what became clear out of the conversation was that, you know, we would've failed if we had not figured out how to maximize the value out of the existing distribution infrastructure, because of the value that it potentially holds. Now it may need some adaptation and some evolution, but the basic bones are there, and we certainly have an opportunity to

turn this into something that is much more like a network.

And then, as we've already started some conversations in California, look for those convergent opportunities -- for example, the water/electric nexus, the transportation and electric -- certainly through electrification of transportation -- and others, like, you know, electricity, natural gas, and so on.

So, if we haven't really thought, you know, more deeply about it, and really led to this, you know, and, instead, sort of end up with grid as a backup -- which ultimately is where the death spiral goes, if you think about that -- as opposed to engaging, and finding ways that it's in mutual best interests for customers and DER service providers to use the grid, then that would've been a big mistake.

But that means that we need to think differently about what we want this system to do. And so you can see the current path here, which is -- as it was called in the session, as Heather

remembers -- more or less business as usual -- or enhanced status quo.

But even there, I think, sometimes, it's not as well-known that during this aging infrastructure replacement, we're actually doing some pretty smart things, you know, in the industry -- probably not as highlighted as well as many might understand. But through that process, many of the -- it's not a like-for-like replacement.

So, it's hard to say what traditional is, because traditional is a moving target based on technology adoption -- or even just changes in the way engineering standard practices are happening -- for example, the slightly, you know, larger wire sizes, larger transformer sizes, et cetera, that are going out -- which actually add to the potential for the hosting capacity to accommodate greater amounts of DER.

But even given that, there's certainly a number of attributes that we need to think about, from an open grid -- creating a platform of this

open grid. I won't go through all of these, but there are a set of principles that were laid out in the paper, and, certainly, has been shaping the discussion and our thinking about how we orient the planning process -- because we wanted to set a vision of what we're aiming for when we start to think about, so how do we change the distribution planning process?

And if you're not aware, there was a law passed in California about 18 months ago -- AB-327. And within that, probably less known at the time -- because most of the focus was on the other aspects, which were retail rate design and net energy metering rate design -- but, often, a corner of that bill actually put in literally at the 11th hour was a provision to change or make an addition to the public utility code, requiring what's called a distribution resources plan.

And it's not just the planning process that it calls out; it also calls out the need to start thinking about -- or not thinking about, but actually implement -- opportunities for

distributed resources to provide service to the utility in lieu of capital investment operational expenses by the utility -- so, fundamentally, the same kind of basic idea that New York is pursuing.

And, as you may know, Hawaii passed a similar law last summer requiring the same kind of thing. So, we have three states' examples here going on this year, exploring these issues in-depth.

In California, we started with the idea that, you know, we would be looking at this analysis. As you may know, distribution planning is done by a distribution planning area, which is a subset of the entire distribution system, not unlike transmission planning areas -- although we're talking about a fewer number.

I'm going to give you an example. Pacific Gas and Electric has 260 distribution planning areas across their 70,000-square-mile service territory, and they have about 3,500 distribution circuits. So, you know, it's a pretty daunting task when you start to think about

changing, you know, a planning process. What's going to be involved in terms of making that happen? It's not just changing the methods, but you've got -- there's education, and training, and, of course, the tools have to be able to do that.

And when you talk about tools, it's not one-off; I'm going to do one research study. I'm going to start to systematize this, and this is going to be the way I do this -- and, oh, by the way, I've got to do this for 260 different distribution planning areas. How do I start to scale this up?

So, this is part of what we've been talking through in California -- is, how do we operationalize it? What do we want? Define the needs, and then, how do we start to think about operationalizing this -- and over what time period? Because it isn't going to happen just overnight, as I'll get into in a little bit.

But part of what we needed to look at was the first question. You know, what can the

existing system or the system that's currently being, you know, revised or updated as a result of the aging infrastructure replacement? And just to give you some context, in California, we're spending, in total, over $5 billion a year right now on distribution infrastructure replacement. So, it's a fairly significant number that's being looked at.

So, this hosting capacity analysis is kind of a moving target, because the system has continued to evolve. The 4KV that used to be there isn't going to be there in two years in some areas; it'll be now a 21KV or some other voltage. And so the hosting capacity's going to be changing. So, this is an annual process now that's been identified in California.

The second part, which has gotten a lot of attention, obviously, is the locational value. So, doing this analysis to look at the net locational value of distributed resources, both from an avoided cost -- but, also, from a benefits side. And I'll show you some of those categories.

And then there's process of identifying where the most beneficial place is on the system by distribution planning area. And at this stage, we're starting at the substation level, although a lot of people have been pressing to go down to the individual feeder level. But, again, you know, depending on scale, and scope, and the utility's ability to manage that -- smaller utilities can obviously do that a lot easier than a larger one, so this is -- but at least at a minimum level, we're talking about substation.

One of the underlying fundamental aspects, though, is, there's a shift from deterministic planning processes at distribution on the power flow analysis into something that's much more dynamic or stochastic in nature. This also parallels many of the kind of evolutions in the transmission planning that's going on, but this is very much what we're talking about in California -- especially because of the large solar PB adoption. We realize that we need to think differently about understanding the

variability on a system and how that plays out -- whether it's directly-connected resources or whether we're talking about variability as a result of the -- you know, reflected in the net load.

The other thing that we've been looking at -- and I'll come to the services in a second -- is, again, how we think about operations differently. And, again, realizing that this may evolve over time in terms of the various choices that exist and how you think about this evolution, but there' a realization that there's going to be some new functions that the distribution operator has in an environment where they're sourcing (inaudible) services from a distributed resource -- which may also be selling services to the bulk power system.

I mean, it's expected with most distributor resources -- for them to make money, they're going to have to sell multiple services to have the revenue to be able to, you know, cover the cost of the equipment. And, as a result, we

need to reconcile how you're going to manage a dispatch by, you know, what the distribution operator's using or the engineers are using, and what the bulk power system's using. And so how do we think about that interrelation? How do we manage that coordination? Because that, as a process, doesn't exist today. So, these are new things.

So, it's not that we don't understand how to do it; it's just something that you have to work through, you have to -- you know, sort of the devil in the details kind of stuff, but it's the kinds of things that will keep a system from working or scaling up. And so we'll be working through that.

On the market design, we've started that process. We're starting with identifying values. These values are the values that are used in the planning process. So, the planning process then feeds into, what are the services that are required, based on the needs by location? And we're in the process right now -- I'm just

starting -- we just finished the values and the methodologies to do the initial planning. We're just kicking off the next stage of our working group in California to focus on service definitions and the functional requirements associated with those that have been called out by the Commission and its guidance for demonstration in the next year and a half.

The good thing is that this parallels conversations that are going on in New York. So, I think there's a strong opportunity to cross-pollinate ideas and learn from each other, and that's been increasingly happening, I think, over the last couple of months. I've just recently engaged as an advisor to one of the working groups in New York on market design. So, I think there's going to be some good information share about what they've been thinking through, and how that might help us, and vice versa.

Ultimately, you get to a set of market structures -- and we think about that, you know, just coming out of our last conversation, around

the idea of what we called the three Ps. So, there's pricing. There are programs, in terms of energy efficiency and demand response, and procurements. And in California parlance, we've been looking at all three.

As you may know, in California, we've been spending roughly a billion dollars a year on energy efficiency and demand response programs, and there's a recognition that, from an operational standpoint, from a grid asset management standpoint, we're getting, like, near-zero value for those, because they're not actually factored into any of the planning -- either transmission or the bulk power from resource adequacy, per se, or from the distribution planning perspective.

And so there's a need to start thinking differently about how we can tailor those programs to be more specifically aligned to those tangible grid benefits. It's not that energy efficiency isn't a good thing; it's just that there's an opportunity with these programs, over and above

codes and standards, to start thinking about how we focus that. And that's a strong interest from the Commission, and they've got an integrated demand side management proceeding underway that we're looking to collaborate with on helping think through some of those questions.

I've got some slides in this deck -- and, obviously, you'll have a chance to see this. I won't go through all these, but we've identified a whole set of valued components, we called them. These also cross- pollinated into the net energy metering proceeding. They're also cross-pollinating into the energy storage proceeding.

Unlike New York, California's got about eight proceedings going on on similar topics, and so one of the challenges we have is, how do we cross-pollinate across all these different proceedings to make sure that we all end up with similar kind of, you know, language, similar sort of taxonomy of these issues, using the same definitions and the like? Because that would

otherwise, as was pointed out earlier today, would be, you know, a pretty chaotic and, really, a nonfunctioning marketplace at the end of the day.

But we've gone pretty comprehensively. In fact, that's the whole approach we used here -- was this, you know, mutually exclusive set of values that are comprehensively exhausted. So, how do we think about this full range? There's another slide in the appendix that has the bulk power system value components and the definitions.

The stage we're in now is, we're going to start taking each of these definitions, start coming up with functional requirements for them, and start creating and defining what services relate to that. And then we'll tackle what the market structures that make most sense for each of these. That's what we're planning to do over the next couple of months.

This just highlights some of the services. This comes out of some work that was done at So Cal Ed. I started this when I was there, and it got finished a couple years

afterwards. And it mirrors work that has been done at Sandia and Lawrence Berkeley National Labs.

And one of the things I like to highlight -- as was talked about today -- there's a tremendous opportunity to not have to recreate the wheel and leverage work product that has come out of the DOE efforts in the labs so that we can basically jumpstart our efforts to adapt those concepts into practice and into regulation and so on in these various states.

So, part of what we have going on is trying to mine these. You know, what documents are out there? What work is already done to define these things? Can we harmonize it? How do we line it up with what we need to do, say, specifically in California or other, you know, jurisdictions to move this along?

One of the things I would suggest is, to the extent that there -- as you see these efforts going on in these states, having an easy place to reference kind of where all these documents that

may relate to these different stages, like planning, and services, and values, and market design -- you know, if there was an easy way to access the information that's out there, the most current information, it would save a lot of time from having to Google everything and try and find this stuff.

But there's some really great material out there that certainly can help jumpstart us.

The other thing, as I said -- and there's, you know, work going on currently, obviously, that you touched on, that you're going to be pursuing -- but we are looking at, how do we think about, as I said, these structures, as (inaudible) to these very services? And, you know, this is a bit of an art. We haven't really done this at distribution, and there's a lot of different dimensions here that are new.

And so, you know, I think there's going to be an opportunity through the discussions that are going on in the various states and at the national level to maybe start to get a bit of a

framework developed over the course of the year that starts to help and guide, maybe influence -- you know, at least streamline -- some of the thinking that's going to go on in the next wave of states that are starting to look at these issues.

You know, while we talk a lot about New York, and California, and, you know, Hawaii's got a proceeding open that they're going to be putting more effort onto in the spring, there's another set of, you know, maybe as many as six states that are coming in in the next wave, starting in the fall, that are going to be taking up similar issues.

So, you know, how do we maybe, you know, take some of the best practices and lessons learned that have come out of New York, and California, and elsewhere that have been, you know, dealing with some of these issues at a practical level, and how might that help these other states as they launch later in the year, as well?

Thank you for the opportunity to share a

few thoughts.

MR. GELLINGS: Why don't we move right to the panel (inaudible). So, not intending to cut you off at all, because I know that the work you're doing is really right on point. I'm sure people have questions for you. Why don't we start with questions for Paul?

CHAIRMAN COWART: It's up to you, actually -- your choice.

MR. GELLINGS: I'm happy to do it.

CHAIRMAN COWART: Okay.

MR. GELLINGS: I don't want to just sit here, so --

CHAIRMAN COWART: Good.

MR. MORRIS: Thank you. The question's for Paul and -- it's two questions. I think they're similar.

But from the Hawaii lesson, where they've kind of overbuilt and didn't really go from deterministic to dynamic engineering on their circuits, is there any value statements, monetization statements about how much they could

have saved, had they started with more dynamic engineering upfront, as opposed to just reacting to where build-out was happening for solar PB?

And my second question is, on a circuit basis, for your average utility, how much does it cost them to go from deterministic to dynamic -- you know, just kind of a general statement, broad range?

MR. HUDSON: On your first question -- do I understand right -- you're asking, you know, how much money they might have saved had they sort of planned ahead, and sort of do this -- and, you know, what New York and California are trying to do now?

I don't know the number for that. I don't know if somebody's looked at that yet -- and not just bulk power system, but, you know, what, on the distribution -- and I don't know that we have the final answer on distribution, because they still have customers that haven't been hooked up yet on solar PB. So, I think that's still a work in progress.

On your second question, my colleagues and I at Caltech, talking with some utilities in California that have been looking at this question -- it could be an additional 10 to 15 percent incremental distribution spend to be able to put the layer in that you need -- what we call system integration costs in California. And in some of this, what EPRI called grid 3.0 in a paper they had put together about three years ago, I think it's now.

So, it's not so much the physical component. You know, that includes some of that -- some of the technologies that Tim talked about -- power flow controllers and the like -- and certainly some storage, but more in the context of as it integrates with managing the grid, not -- I think, as New York had sort of called out -- I think consistent with that view. But mostly, it's control layer -- additional measurement observability kind of capability and so on.

MR. GELLINGS: There are some interesting anecdotes out of Germany, which show

you a phenomenal cost difference for not planning ahead. We don't need to go on about them, but, for example, this idea of a million truck rolls to go back and retrofit inverters, the now-almost-$50- billion investment in reinforcing lines, and in putting in the communications infrastructure to handle some of the visibility that's actually required. But some of you might immediately say, as people have in conferences, "Oh, well, that's Germany; it doesn't apply here." Lesson learned.

MR. MORRIS: Just as a followup comment -- you know, in states that are just creeping out to 0.5 percent penetration -- and maybe EV cars are going far ahead of that -- you know, not having avoided cost numbers makes it difficult to make the case, other than just it's the right thing to do. So, if there's any lessons from Hawaii, those would be really valuable, I would think, to make the case for this.

MR. HUDSON: Well, one of the things that -- you know, this comes up a lot, actually,

in a lot of the conversations -- is, you know, where do the threshold points between stage one, stage two -- you know, where do you need to be, you know, that you need to start looking at these incremental investments, and how much do you need to do from a systemwide standpoint, you know, versus, okay, I've got one area within my service area that is starting to have a lot of adoption, but, you know, the rest of the service area doesn't -- how do you think about that?

I think that would actually be good research work, you know, to the extent that people -- I think people have been looking at pieces of it, but synthesizing it to actually come up with some milestones and some reference points -- and I think the other thing that people have been asking me a lot is, so what are the signposts that let you know? Because it takes a long time, as people talked about, to do these structural changes, so you can't wait until you're on top of it -- which is, you know -- that's a lesson in Hawaii and almost in California.

You kind of want to be looking at that down the road, so you've got time to manage this in a way that, you know, you're not ending up in a bad situation -- because the bad situation is, yes, the grid doesn't operate that well, but, more importantly, if there's a lesson from Hawaii -- the customers are very, you know, upset. They're not getting the service that they expect.

MR. GELLINGS: Let's move on. Sonny?

MR. POPOWSKY: Yeah, I also had a question for Paul. You had a slide on the locational values of DER. Do you think you're looking to -- or do you think one of the end states here is locational tariffs, pricing, distribution tariffs that talk about the value, neighborhood by neighborhood, of -- you know, if you put a solar panel in, you're going to get this; if that guy puts in a solar panel, he's going to get that.

MR. HUDSON: Yeah, possibly. I think the -- and when I say that, I think you need to separate this into two pieces. And one piece is

the energy and generation capacity value that, today, is really a wholesale value -- and how that might extend down to the distribution system. Unless and until we have a separate actual market where there's peer-to-peer, business-to-business sort of energy transaction across distribution independent transmission, it's still sort of a construct of the wholesale market, you know, on one level.

And so there's conversations about, do you extend L&P, and how do you think about L&P pricing down and distribution? That's somewhat different than what some have been talking about, in terms of a distribution marginal price, which largely isn't energy or generation capacity; it's the value of, say, deferred capital, or avoided capital, or avoided operational expense, or things like voltage or reactive power and distribution. And those aren't necessarily energy or generation capacity values.

And so that is still -- there's a conversation about that, but it's somewhat

different. What we've been focused on in California in the near term is, what are those distribution-level values? How far can we extend that value down into the system? So, right now, it's at substations, the analysis that we're going to be doing. And then, you know, we are exploring, how far, you know, down the feeder, if you will?

The thing to keep in mind is, for every feeder -- if every feeder had a price node in California, you know, you'd end up with about 10,000 different price nodes. But the other thing to keep in mind is, each -- because we run on balanced distribution systems, each phase would need to have its own node. And the other is, people are talking about sub-feeder nodes. So, if you broke that up into where the (inaudible) switch is and so on, you could end up with five nodes per feeder times three.

And, you know, the ballpark estimate in a conversation earlier this week, you know, on a panel like this at So Cal Ed was -- just for So

Cal Ed alone, they could end up with 60,000 different price nodes. So, is that really practical, in terms of what we're trying to get to -- in terms of, you know, how far do you need to go to get the economic efficiency? So, this, I think, is also an open question -- how far down into the system do we need to go to get that?

MR. GELLINGS: Richard?

CHAIRMAN COWART: Oh, I have about three questions, but I'll just ask one. One of the challenges that I see jurisdictions facing with respect to this question alone is, what's the future role of the distribution utility with respect to the provision of -- outside planning for and provision of DER? You know, there are some utilities that say, okay, we're facing the future, and the way we're going to face the future is, we're going to provide solar panels, and electric car-charging platforms, and you name it -- everything. And it's a noncompetitive view of the world.

And then there are other people who say,

well, hold it; no, we want the distribution company to be like the ISO. We want them to be neutral, and allow Google to come in and do whatever, and the electric Tesla to do whatever.

So, my question for any of you is, how do you see that playing out?

MR. HUDSON: Well, again, it depends, you know, where you are in the U.S., and what type of utility we're talking about. So, are we -- you know, is it restructured, and is there an organized market already in that area? Is it investor-owned versus a publically-owned utility -- and so on?

So, depending on the nature -- because, in some states, the utilities -- like in Texas is the most extreme example, in terms of, you know, pretty much modularized in terms of -- and separated from these kind of questions.

But you have many other states that have gone through restructuring in the late '90s and early 2000s that today are not able to provide any of these competitive services. I think Illinois's

that way. Mostly New York, I think, in some way -- and Pennsylvania, the same.

So, you already have a lot of other states that went through restructuring that don't really allow the utility to get into that side of it.

Now you have other states, like California, that had essentially precluded the utility from doing a lot of that, but has been rethinking that, as related most recently -- or I guess it's still an open conversation in California about electric vehicle -- and so how much of the charging they might be able to -- certainly, in the energy storage, there was a carve-out as part of the 1,300-megawatts of storage that of the roughly 500 -- for each of the categories -- both power system distribution and behind the meter -- the utility could have, you know, 50 percent of those numbers itself.

So, you know, I think it's still an open question to see how this plays out. People are very concerned about the potential of an

equivalent of a digital divide -- that the market may leave some people behind, and so how do you deal with some aspects of that?

But, at the same time, how do you create functional separation, even if it stays -- even if you want the regulated entity to do part of this, I think it's pretty clear -- and I think there was some good comments in New York about, is there an opportunity to leverage the equivalent of the FERC Standard of Conduct, to be able to think about functional separation within the utility around the operational dimension and the potential marketing side of it?

And that's been very effective at FERC. And, you know, some analysis that myself and some others looked at, I don't think there's been any violation by a utility of the FERC Standard of Conduct in the last 10 years around, you know, these kind of issues for the bulk power system. So, seemingly, we ought to be able to do this, you know, at distribution.

MR. GELLINGS: Wanda?

MS. REDER: Good comments, everyone. I want to pick up a little bit on where Paul left off, as far as the planning needs going beyond the substation. It seems to me like we're going to -- we're ending up in a situation where it's very dynamic, and, you know, location does make a difference. It is three-phase, but this question kind of spans across all three panelists, actually, because I think there's been a lot of good work done in the labs -- so a lot of work done at DOE.

We know that this is a need. We need to figure a way to get this both in the utility domain and, also, you know, into software platforms that others can use.

So, can you kind of take them as a little bit of assumption that we need these tools, and how do we kind of get there from here?

MR. HEIDEL: Well, so I've worked a lot less at distribution, where I think a lot of this conversation has been. Yeah, I mean, so I think the first question becomes, what problem are you

trying to solve? And that's been something that has been a big issue for a lot of the teams we've been dealing with thus far -- is, it's extremely hard to quantify the avoided costs -- coming back to the question from before. It's, what is the actual benefit, right?

There's two routes you can take on this. The one route is to do exactly what you've always done, which is treat, in particular in distribution systems, treat it as a planning problem, right, and do the best you can at making aggressive assumptions about what the future looks like, and build a tremendous amount of infrastructure.

And, okay, you have low utilization. Do we absolutely know that that's far too costly and can't be done? Because the other route is far more complex than that, and it's thinking about actually optimizing the distribution system in realtime.

Now I think eventually, you get to the point where you have all the bells and whistles in

a full market. The first implementation of that looks something like what we've been working with Steven Low at Caltech, or with Varentec out in California, where they're solving one problem, and it's voltage management in distribution feeders, and they can do it either through centralized or distributed approaches. But it's just solving that one problem.

And that first implementation probably doesn't have a market structure wrapped around it, but I think what you're seeing out of what Paul's doing, and what Jeff's doing -- it's unfortunate he wasn't here this afternoon -- is thinking through, okay, how do we fit all the pieces together once they're available?

But right now, that startup down the street, what are they doing to do, or what's the vendor going to do? They're going to solve one problem. And so I would be focusing on, what are the mechanisms by which we have to allow utilities to solve one problem that is their burning issue right now, through means other than simply just

building a tremendous amount of infrastructure?

I don't know if that answers the --

MR. GELLINGS: Good viewpoint. Thank you very much. Audrey, did you put your ten up and down, or --

MS. ZIBELMAN: I put it up and down, but I actually have covered both conversations at this point.

MR. GELLINGS: All right, excellent. Paul?

MR. ROBERTI: Paul, I really appreciate your presentation, and just wanted to offer -- not so much as a question, but a comment -- that just a few days ago, we had our distribution utility -- and Rhode Island has a very aggressive program to deploy distributed resources to the extent that it would meet 15 percent of the state's peak lead, which is pretty aggressive, and in questioning utility on what we have as an asset replacement model, the whole world of integrating renewables and what the utility is doing right now, in terms of replacing a certain amount of poles and a

certain amount of transformers, are totally divorced.

And, essentially, the testimony in the record was -- in terms of long-range planning, for where we ought to size the distribution system best to meet the potential for incorporating the renewable systems, we were flying in the dark. And this happened, you know, a few days ago, and that's the state in Rhode Island.

We're trying to do something about it, and Heather's going to send me a whole bunch of information -- and maybe some draft legislation. So --

MR. HUDSON: Well, and you summed up what we -- that was the task we had, which was, so how do we redefine that planning process to not only deal with the traditional -- you know, how do we need to enhance the traditional, but, also, how do we think about this locational benefits piece in this new context of -- not only is it, you know, from a policy standpoint, what is the state trying to do to encourage adoption, but what are

customers doing themselves, independent of any sort of more direct, you know, incentives and the like?

Because we are crossing over into retail (inaudible) you know, in places like California, so that, yeah, you can tweak some tariffs on the margin, but it's still in the money. So, people are still doing it, and we expect that to increase.

So, this has been part of the conversation in California, and I'm sure this has been happening -- I've got to believe this has been happening in New York, where people who hadn't normally talked to each other are now having to talk to each other. And part of that is, how do -- you know, they learn each other's kind of perspective, and then how do we collectively start to figure out, you know, the path forward?

MR. ROBERTI: A comment -- in this program, we may be upgrading transformers or substations in specific areas. Once we do that,

tomorrow, there may be a renewable proposal that can't be accommodated. And then 100 percent of those upgrades fall on the developer. And it just is this --

MR. HUDSON: Yeah, that's what's behind this --

MR. ROBERTI: Will we have the ability to anticipate this, and try to facilitate it?

MR. HUDSON: So, that's what's behind the hosting capacity -- or what we call in California the integration capacity analysis. And that'll be an annual -- you know, part of the new distribution plan will be this analysis. And it'll be published to a website to show where these areas are. And then that's also expected and informed this ongoing planning process to look at, also, with all this money being spent on aging infrastructure, how do we start to tailor that? Because, right now, that's not aligned, necessarily -- to your point of where development's going. So, can we reprioritize that spend?

And then many of the utilities in California have also created essentially steering teams that are looking at trying to minimize the standard asset risk by not thinking through what's really going to be needed five, ten -- because any investment today is essentially a 30-year bet on the future, right, in distribution.

MR. GELLINGS: Tim?

MR. MOUNT: So, this is a question for Paul. A standard type of rate schedule for a wholesale customer is sort of maintain your power factor in a band, or we'll slap you. To what extent have you looked at that being extended to residential customers using what I believe are called ARCs -- aggregators of residential customers -- to avoid the sort of problems that you get with net metering and essentially making those customers appear like a wholesale customer?

MR. HUDSON: Well, in California, we haven't quite gotten that far in the rate design dimension. It's coming up in the discussion around the planning, and you can't ignore those

questions when you're talking about all these other aspects of, you know, locational value, and where there's issues, where there are not issues, and so on.

So, you know, this is starting to come up. I think this question -- that are going to be -- I think a lot of people are looking at track two in New York, and they're very interested to see some innovative thinking around, you know, how we may move more from, you know, kind of the way we do, you know -- collect revenues on distribution, and move into more of a services model, not unlike transmission or other networks like telecommunications. There may be some interesting things that evolve over that.

I think we're going to get more into that in the country, you know -- particularly in places like California -- over the next couple years. It's not right now immediate that they're trying to deal with some, you know, even simpler -- you know, more basic stuff, I should say -- not simpler, but more basic issues.

MR. GELLINGS: It has come up in the state of South Australia. You might look at some of the literature. Audrey?

MS. ZIBELMAN: First of all, I appreciate the comments, as well. The other thing that I would sort of -- a couple of observations coming out of New York that I think we should be thinking about as sort of how (inaudible) -- one is, we are also doing the integrated planning, but the other thing is that the objective that we have, that we've laid out for the utilities, is around driving systemwide efficiency.

So, one of the things I think is important is that, from our viewpoint, price formation for energy and capacity is still going to be happening at the wholesale level. The issue is really the role of the distribution utility and optimized demand, which will then have an effect writ large on L&Ps. And so we don't see it at this point to see a large value in getting to nodal pricing at the distribution level, with the exception of looking at investment in assets.

So, to the extent you have feeders that are deficit in having distributed resources on the feeder, we want to send those price signals. But having actual realtime price signals, we don't see it happening in any near term -- nor do we really see us getting into option markets at the distribution level, which is why we were comfortable with the distribution utility really having a function of optimizing the system in response to L&P, as opposed to operating a separate option.

And that's how we saw we would get alignment from the wholesale market to the retail market. So, it really was taking a lot of the price-responsive demand concepts that PJM developed, and trying to operationalize those through both regulation and the market.

But the other thing that I think is going to be really helpful as we think through this, just as, you know, a role of DOE is, see if we could create some sort of mechanism so that we could have standard products, standard APIs,

things like that. So, you know, I spend a lot of time talking to Chairman Picker in California, and it's on both our minds, you know.

And I think Nate working with some of our neighboring northeast states -- you know, trying to create these markets so that when people are writing their products, they are bound to do something differently in New York than California, et cetera. And I think that would be another area where maybe you folks can help us -- is, try to figure out, how do we identify product standardization at the retail level?

MR. GELLINGS: Any comment needed?

MS. ZIBELMAN: No, (inaudible).

MR. GELLINGS: Paul Roberti, is that another hit, or -- your flag is up.

MR. ROBERTI: No.

MR. GELLINGS: Okay, good. Granger?

MR. MORGAN: I'd like to go back to Billy's question about how ARPA-E selects its projects. I mean, on the one hand, we know that there's going to be substantial evolution in the

nature of the grid. On the other hand, at the moment, some of the regulatory and incentive structures that will facilitate some of these transformations aren't in place.

Billy basically said ARPA-E ought to go out and talk to the existing utilities, the legacy utilities, about what they need. So, could you talk a little bit about -- given the relatively short time scale over which ARPA-E projects take place -- how you think about balancing the need for what many of us believe we're going to need out there, but for which there's really no viable market environment at the moment, versus only working on the stuff that existing utilities say they want tomorrow?

MR. HEIDEL: So, I can tell you how -- well, let me push back a little bit, actually. I don't think we've seen a technology thus far that doesn't have a niche application that provides high value in some particular setting that may not be the ultimate point of adoption for the widespread benefits that we're looking for. But

if you look hard enough, and you listen well enough to both utilities and other customers, you can find that pain point.

And where we haven't found it, we haven't listened enough yet. And I think that that's a message that we're constantly berating our teams with -- is, go out and talk to utilities, go out and talk to customers. Find that pain point, even if it means adjusting exactly what your technology looks like, or how you're going about it right now. You can almost always find that early-adoption standpoint.

You know, what that means is, you can develop the technology, you can mature the technology, and you're not dependent on that future market change for your immediate survival.

Now often, you are going to be dependent on your long-term survival on some market change. We have no better reading of the tea leaves than anybody else in the room about what that looks like, and we probably have even less influence than everyone else here in the room on actually

enacting those changes, right? We're all technology folks focused on providing toolkits in the toolbox that you can pick off the shelf.

Now, that being said, before we select projects, we always hold public workshops where we pull in experts from industry, government, academia to give us feedback on the targets we're pursuing. And we've routinely had public service commission staff, as well as commissioners, at those workshops. We're also constantly in those dialogues while projects are going on, trying to make sure the teams are working with those commission to figure out, you know, what is and isn't permitted, incentivized, allowed today, versus what could be tomorrow.

But these things don't move fast. And so there's no good silver-bullet answer. I think you're right, though; we can't focus only on those things that the market's ready immediately right now, and it's going to have that huge impact. What that means is, we end up falling back on first markets to help the team survive. In some

technology areas, that often means a DOD application. Certainly, in the power electronics space, most of those teams are looking for early DOD applications before the commercial market'll pick it up.

MR. GELLINGS: Thank you. Paul Centolella?

MR. CENTOLELLA: So, given this panel and the four of you sitting next to each other up there, I'm wondering if there are opportunities -- and if not, what are the barriers -- to take Tim's last question of, how do you take new technologies that have gotten to proof-of-concept stage but are not yet commercial, and build them into these emerging planning processes, you know, and market developments that we're seeing in a growing number of states?

And does that provide a forum for, you know, at least beginning to get some more first adoptions of these technologies? And if so, how do we facilitate that? And if there are barriers, what are those barriers that we should be thinking

about?

MR. HUDSON: So, I mean, great question, Paul. And I think there are at least two dimensions, I think, to build on your point. One is that through these changes in the planning process -- I mean, one of the things that's unique about this, particularly the way we've approached it in California, is, the planning is technology-neutral. So, it's just defining what needs are, and, therefore, it's not predisposed to one thing or another -- which is kind of how it was in the past and a bit.

So, because it's technology-neutral, you're not having to sort of figure out the predisposed bias towards one thing or another or one vendor or another, right? Because that also plays out, too. So, that is at least a better starting point. Now this is going to take some night. It's not going to be an overnight thing, but at least that's one dimension.

The other is that because we're talking about and starting to understand better the value

that these technologies have -- because you're changing the way the kind of analysis that you're doing, this starts to expose and better understand what that device can do -- because today, for example, if we take a power flow controller, and think of it as only a voltage or a reactive power management, often that gets compared to a capacitor bank. And if you're only trying to do basic, you know, five, ten- minute, hourly, twice-a-day voltage management, you can never make that power flow controller pay off.

Now if you're doing an analysis that's more, you know, probabilistic, and looking at the variabilities, and looking at all these kind of different changes -- and, oh, by the way, you also want to take advantage of the fact that you could actually kind of shift power a little bit, you know, to some degree, as that may evolve over time.

Now, all of a sudden, you've exposed that. The capability of that is starting to be really shown in the planning process that shows up

-- whereas it didn't before.

So, I think with these changes, we'll start to see -- particularly for distribution level, but even for some of the transmission-level devices, you'll start to see, you know, those values start to be more exposed and an opportunity. It still doesn't address the other fundamental issues said, which is, there needs to be a better onramp from the utilities side. A number of the large utilities and a few of the, you know, sort of leading, smaller, you know, publically-owned, you know, utilities have some, but it's not a pervasive thing where there's an understanding of how technology gets adopted into the mainstream building materials, you know, for a system.

And that's something I think that, you know, the industry could look at, as well.

MR. GELLINGS: Tim?

MR. HEIDEL: Just -- I'll spin the question back on you. Who's awarded by making that risky investment in new technology?

MR. GELLINGS: It's a rhetorical question.

MR. HEIDEL: Yeah, we don't have many award structures today that actually award you for trying serial number five. We've got lots of things that are going to hurt you.

MR. HUDSON: I mean, Paul, this is -- I'm sure this is going to be, you know, preaching to the choir, but, I mean, this is one of the elements in the U.K.'s Rio model that is actually quite interesting, right? It's the R&D component that they've got.

MR. GELLINGS: I have any number of utilities, as we engage with them in technology discussions, who say, "Yeah, but the Commission is likely to turn around and disavow that." Anjan?

MR. BOSE: Just a follow-on question to what Granger was asking to ARPA-E. I think the GENI Program was rather interesting -- that some of it were power flow controllers that were widgets -- the things you hang onto the lines. And there were some that were just software --

that were operating the grid.

And I was wondering if you saw a difference in which ones got better response on the marketplace.

MR. HEIDEL: It's so dependent on the individual team, the individual technology, what problem they were specifically trying to solve, who their partners were from the get-go. And so it's hard to generalize about hardware versus software.

What I can tell you is that, early on in the program, we observed something very interesting. And that was that -- specifically on the power flow control side, okay -- the hardware teams that were focusing on developing the low-cost, reliable, robust power flow control hardware would tell you with an absolute straight face -- they were dead serious -- that the hardest challenge to solve was developing the hardware.

And once they had proven that they could develop a prototype that was cheap enough, reliable enough, and had all the safety

requirements met, then these things would proliferate everywhere, okay?

You then had software teams that said, "No, the challenge is in the algorithms, and we simply don't have the algorithms that can solve fast enough that can solve fleets of those devices. And if we solve the algorithms, and we can get those to solve fast enough, the hardware will just show up, and it'll be there automatically."

And so one of the really fun things about the program itself was getting those two groups in the same room, and realizing that both problems are really hard, and you've got to work on both problems, and you can't do just one or the other.

Now, that being said, the software often gets implemented first, because it can run in parallel. And so I think you are seeing a willingness today of people taking a new tool, and putting it on a screen, and it's over in the corner, and they'll use it. It's not replacing an

existing tool -- and so, at first, has no actual, real implication for operations, but you're starting to see what the value might be, right? And then if it's useful, it'll start to get used.

You can't necessarily do that with hardware; it's either there or it's not. And there's no option to not use it -- or have it not be connected. So, hardware can turn out to be much tougher under some cases.

MR. GELLINGS: Richard, can we take this one last --

CHAIRMAN COWART: Yeah, I was going to suggest this should be the last question; then we'll move onto cyber security. Thank you.

MR. SHELTON: I just wanted to applaud the discussion about the work in California, because you've mentioned several times that you're focused on the needs, and making the needs transparent, and it's that hierarchy of needs. And I think that subtly does introduce an opportunity for the new technology to come in that Paul was mentioning.

I think a great example of this is, you know, PJM manual 11 describes frequency regulation, and what the characteristics of resources are that are required to provide frequency regulation in PJM.

And nowhere in the manual does it say anything about a power plant, or a rotating mass, or inertia, or anything. It just says, "These are the characteristics of a resource that would qualify. This is the test. This is the need." And so, you know, things have been able to come into that market, and do that service without any fanfare, no change. And so that is a place where someone would take risk on unit five. And people have taken risk on unit five to make money with a new technology -- be it demand response, aggregated resources, storage, fly wheel batteries, fly wheels, whatever.

So, there are examples where that does happen -- where if the need is defined, and the market is abstract and transparent, things come to bear. I really think that is what New York -- you

know, part of what New York's trying to do, as well. So, I think it can happen.

The flipside of that is, on the regulated part of the business -- which I think we will have, going forward -- I would say stagnation is imprudent. So, you know, progress is prudent. So, I think we have to figure out how to incorporate new things. I mean, I think what Paul's saying is right; we have to figure out that part of a performance- based rate is the adoption or testing of new technology, and bringing them in to meet these needs.

MR. GELLINGS: I take that as a comment. Richard, over to you. And let's thank this panel first.

CHAIRMAN COWART: All right. Thank you very much. So, our last topic for today is a report from the EAC Cyber Security Working Group. Andy? And we have time for a short discussion following that.

MR. BOCHMAN: Thanks, everybody, for still being here. We always save security for

last; it's kind of like dessert. You've had a full meal. We keep security short, also. You don't want too much of this sweetness, so I'm just going to give you, hopefully, a right-sized dose that'll satisfy your craving for security for a little while longer, until we meet again next time.

My name is Andy Bochman. I'm from the Idaho National Lab. That's the second Idaho reference of the day. But the work that I'm going to be describing to you is primarily that of the principal author, Roland Miller III, from Florida Power and Light. Roland, Chris Peters, VP of Entergy, who's presented to this august body in the past -- myself commented and had interaction with Roland, but this is primarily his work. And I believe that if we were to do some -- if you all were to recommend some followup activities, that it might very well involve him, okay?

The title might seem a little bit off-putting. Myself, I didn't completely grasp it when I saw it, but I think I can -- my job is to

make this approachable for you, and, I think, give you some things to take away from it.

In short terms, we're talking about information sharing. You hear on Capitol Hill when legislation is in motion -- and cyber security is an overwhelming challenge in all sectors -- and in our sector, too -- we hear that information sharing's what potentially has a chance to save the day. Roland has reduced that abstract concept into just a handful of pieces that I'm going to try to convey to you right now -- so with a flip of a switch, let's see. Okay.

So, I'm going to give you just a couple terms. He's talking about cyber threat intelligence, which is basically information that a utility -- and the people that help manage security for utilities -- the information they need to know about who's attacking them, who's going after them, what the adversaries are doing, and how they're doing it, okay?

It's made up of some components -- tactics, tools, and procedures -- how we do these

activities, and it also involves the evidence that somebody is trying to do something nefarious to our systems. And the blanket term for that is "indicators of compromise." How do you know something is going on? It's the indicators of compromise. Here, I'll show them to you; this is what's happening to us.

And, lastly, it's the fact that these items are shared -- shared in a very carefully-prescribed way. So, Roland is describing -- this is all the layout for some of these recommendations -- he's describing an ecosystem, right, and it has three main players, if we don't count the bad guys. We have four if we include the adversaries that make this all necessary in the first place.

There are the producers of the threat intelligence. There are the consumers of it -- and that's a one-to-many relationship. There's only going to be a comparatively small number of producers for everybody that's a consumer of the intelligence. And, by the way, producers are also

consumers, at the same time.

And then there's an intermediary, a broker that helps reduce the noise, reduce the false positives, that helps tailor the information in ways that makes it more immediately actionable to the consuming utility, so that they're not overwhelmed. They all have day jobs and a million other things to worry about. But this is something for them that's increasingly concern them, too. And that trusted broker in our sector is the ESI -- electricity sector or subgroup, information sharing and analysis center, okay?

Now there are a number of ISACs. Perhaps you've heard the term in the past, related to financial services. They're often given credit with being one of the first movers -- a club of folks that its job was to protect banks and other financial companies in New York -- got together regularly and shared notes. And out of that has grown a trusted relationship that seems to work pretty well, and the processes they use are quite mature -- serving as a model for other sectors.

Our sector's considered to be relatively mature, by the way, as well. We're not late to the party; we're just not as mature as the financial services folks are.

But each one has different attackers, using different approaches to get at their specific systems and to take advantage of the processes that are relatively unique to them -- and, hence, the need for this ecosystem that's sector-specific, okay?

So, what would be a nicely-operating system? What would it look good if things were working well? I mentioned financial services being mature, but, also, we use a model from the defense industrial base. And they show that in order for this to work, you have to have a critical mass of producers; you can't just have one or two different agencies creating and disseminating the information to the broker, because it wouldn't cover all the different use cases -- or it wouldn't cover enough of the use cases to be helpful to the large base of

consumers.

It's also important that the majority of the sector be set up to be consumers. So, if you had producers, and you had a broker that were generating this information, and helping targeting to you, and they're throwing it to you like a pitcher, but you've got no catcher's mitt, and you have no glove. You don't know what to do with it. You have no one assigned to play that position -- then that stuff's just going to go whistling past your head, and it's not going to have turned out to help you at all.

So, while we're not going to talk about it much in this short talk, it may be a follow-on activity that defines, whoa, if we're getting our game plan together for producers -- and I'll say a little bit more about that -- and we know who our competent broker is in the ES-ISAC -- what does it take, at a minimum -- what are the minimum requirements in people, and technology, and process to be a mature and competent consumer of this -- to make best use of it, okay?

So, I'm going to walk you up the stack on the right. I think this is our only real visual aid here. Maybe there's one more little one. But, basically, if you look at the bottom, there's a lot of acronyms -- kind of like Tim Heidel acronyms, but different for the security world -- but these are different foundational security tools that mature information security and operational technology security companies deployed to help themselves.

One stack up above that, off of the very bottom, it's the teams that use these tools, that are trained and know how to deploy them. The acronyms -- security operations center, network operations center, incident response teams. These are the guys that use these tools on a daily basis and know how to drive them.

As we move up into the middle of that stack, there's the identification of a team who's -- and at first blush, it's probably one person, one guy, one gal -- but it's the team. It could become more than one person, and it's somebody

that's taking advantage of what's flowing up from those tools and those processes out of the security operations center, for example -- is building a program using specialized tools of their own that's going to do two things. It's going to feed information up further, up to the coordinating council -- ES-ISAC and others, as you can see here -- and, also, is going to be able to make sense of some of this information, and feed it back down themselves.

As I said, producers are also consumers. So, they'll be feeding it back down to their teams, so that when a new threat from an adversary -- far away or not too far away -- is identified, and we know what it's targeting, and it's a piece of equipment that is in my utility, and it performs an important function, and it takes advantage of a particular way a certain system is configured -- and if I don't do something about it pretty soon, it's going to roll across a bunch of my systems, and potentially cause a serious problem.

You want to be able to package that in the proper context so your guys know what to do with it right away and can deploy it.

Sometimes, this is a very human process, but we strive -- and perhaps you'll hear in subsequent meetings with EAC -- we're trying to make this more and more a machine-to-machine process so that things can move more quickly. And we'll do that with things that are simple to do that with first, and then we'll work towards increasing complexity over time.

So, that's the ecosystem as described by Roland. And now here's his sort of how you'd grow it; how you would evolve, okay? There's the ES-ISAC again. Most utilities are not set up to be consumers, let alone to be producers. So, there is a bit of a long road to hoe here before we get to this aspirational state.

Certainly, I did a survey before I joined the Idaho National Lab. I was an independent consultant. Last time I was here, in fact, was for a presentation on security

governance with Chris Peters. And one thing I learned from speaking to several dozen utilities of all sizes was that the large IUs -- some of the large IUs are among the best security operations in -- I was going to say in the world; I'll at least say in the country -- really amazing teams, with strong amounts of resources.

And they're great in part because they know that they're not bulletproof. The best security teams will not tell you, "Don't worry about it; we've got it." They'll say, "We're working on it. We're concerned. It's never going to end, but we're doing pretty good. We learn all the time," you know. So, I'd say our sector has some of the best.

However, we have thousands and thousands of entities. Our sector has, also, teams where, when I ask the CEO to speak to the head of security -- I'll be Northeast; I'll say a Northeast coop -- it was about a 100-person outfit. He said, "Okay, you can speak to my security guy." And when I spoke to security guy,

I said, "Usually, I begin by asking you what your title is, and what your responsibilities are." And the gentleman said, "Okay, I'm the head of safety, security, and building maintenance. I spend about one percent of my time thinking about security. And when we're done with this interview, I have to fix a toilet."

So, that's the range that we're working in as we're thinking about, what's a competent consumer of threat intelligence, and who could be a competent, mature producer of threat intelligence that might trickle down, even to that lonely person in the Northeast coop in a manner that he could take some action that would help shore up his resources, okay?

The parts here on the bottom here -- I think we have this already. I think we're okay for now. But as you can see, there's a foundation of security competence, and then there's minimum requirements to be a competent consumer. And then on top of that's going to be a relatively small number, who we will ultimately call producers.

Okay, so that was the exciting part. I think this is the last slide with core content on it.

There are things that Roland, and Chris, and myself put together, where we think DOE could play a helpful role in maturing these processes and capabilities. One is -- we've mentioned them here already, but to look at the mature ISAC communities that exist already, identify best practices from them that fit for us, and then tailor them accordingly so that we are not reinventing wheels that already exist.

The second thing is to identify processes, vendor- agnostic tools, capabilities, and staffing requirements, in order to become a producer -- and, I'll say later on, in order to simply become a competent consumer. And that's related to that third bullet there -- specify the steps that it takes to move from each of these evolutionary stages, right?

The last two kind of go together. The representative cross-section of the sector has to

be formed so that we can have what we think is at least a handful of competent producers. It may be more than five. It may be 10 or 15, but I think we'd be starting by identifying two, three, four, or five. And we have a program that's already -- DOE has a program that PNNL has a leadership role in, but that other labs may play a role in -- and, certainly, technology providers play a role in -- called CRISP. It stands for Cyber Security Risk Information Sharing Program. And it's actually already moving down this road in a semiautomated fashion.

And its utility is primarily drawn from the Electricity Sector Coordinating Council, who deploy technology, and that generates threat information that gets combined with other sources of information from the United States government, and then comes back to utilities and their participants in the form of actionable threat intelligence that can be deployed to secure their particular systems.

So, I think the last bullet here is,

let's make sure we make the most of the CRISP Program in its current state and its future state as we start to work towards identifying competent producers and competent consumers of this information.

That is it, with the exception of showing you Roland's smiling face. He's in Florida, if you want to visit him -- or maybe we'll get him up here. And that's myself.

Any questions? How was dessert?

CHAIRMAN COWART: Dessert was excellent. Thank you very much. Are there questions? I see -- Paul?

MR. CENTOLELLA: So, I read the background piece for this, and I was actually kind of startled by some of the statistics in it, you know, indicating that, you know, only four percent of the information that was being shared was coming out of the electric sector -- and that there was only about 20 percent overlap in the information that is relevant from one sector to the other -- which led me to one of three possible

hypotheses being the case -- and maybe there's some other explanation, but three possibly troubling hypotheses.

One is, we don't have enough good producers in the electric sector, which would not be helpful.

You know, secondly is, we have good producers, but, for whatever reason, they're not willing to really share the information that they have. And there's been some discussion in the past about, ES-ISAC and its relationship to NERC, and the concerns about potential regulatory actions if you share information.

And the third possibility is, you know, we have good producers, we're sharing the information, but we're sharing a bunch of information, as well, that is really extraneous to the rest of this sector -- which makes the person in the 100-person coop in the Northeast totally unable to use whatever information is out there and being shared.

And I don't know whether any or all of

those hypotheses are accurate, but I find each of them troubling. And I'd like to know more.

MR. BOCHMAN: First of all, when I saw that statistic, I had to track it down a little bit myself, too, because, as Paul said, it does make it seem like we're starting from a -- we're beginning at a very low starting point, in terms of type of information specific to our sector that could be helpful to our folks, you know.

The response is, yes, it does seem like that is, in fact, the case. A lot of the information that comes in as threat intelligence is stuff that's targeted towards IT systems in general or business systems, which is not really very sector-specific. It is relevant to us, though, in a way. I think maybe the interpretation and the percentages are a little low in a little bit overly pessimistic way. That is, a lot of the way adversaries attack asset-intensive industries like the electric sector is, they go into the soft spots. They go in through IT. IT's connected to internet and

business systems, et cetera. They get there.

Having achieved that penetration, which wasn't all that hard -- even in a company that has pretty good hygiene, there's going to be ways in. Then they move -- the idea is called "moving laterally." You move laterally into operational technology -- hence, information about how people are taking advantages of vulnerabilities in IT systems does apply to our sector; it's not particularly sector-specific. But if our security teams can be on the ball on that, they are denying adversaries that relatively easy pathway in.

I do think we have a competent -- and what I think's going to be an increasingly strong broker in the middle -- in the form of ES-ISAC. The critique of or the concern about ES-ISAC from a trust -- and I don't think I emphasized it; I might not have even said it -- none of this works without trust.

So, I think that addresses sort of two points from Paul. One is, is information out there and being produced, but no one's sharing it?

I think we don't really have enough competent -- or any, maybe -- but let's say enough competent and mature producers of this stuff in our sector -- meaning, a handful of strong utilities. We have some that are poised and in position to be that, but they're not really there yet, and they won't really be, I think, until Pat Hoffman and others help them along the way in a sort of formal way.

The concern about, yes, ISAC being part of NERC -- part of the enforcement part, and making utilities clam up because they don't want to say anything to the ISAC, because it's going to come back to haunt them in the form of a fine -- all I can say is, Tim Roxey, at the head of ES-ISAC, is moving heaven and earth to make that distinction increasingly, viscerally clear -- that they are not the same thing -- that they do not share stuff. And I was just with him this morning, and a number of things are in motion that will prove to people that are still harboring doubts that information goes across that wall --

that it's not a concern. That, in reality, is what I'm saying is true. There's always going to be lingering perception.

So, in a sense, there's going to be some marketing, right? They have to do marketing and communications. Look, we're not the same thing, you know. We might've been in the past; we're not the same anymore. That'll probably take a couple years, but they'll have to go out of their way to make sure they get that message across.

CHAIRMAN COWART: All right. Looks like we have a lot of interest. I have Clark, Granger, Carl, Billy, and Roy.

MR. GELLINGS: Thank you. This is a comment. I know you're fully aware of this, but because it wasn't mentioned, I just want to highlight the physical security part, and then the integration with cyber security -- because the increasing concern that we have expressed by our members as we are doing work with them is that understanding by recognizing what the coincidence could be between a physical and a cyber attack --

being able to monitor that, and then being able to, of course, guard against it and so on and so forth. So, I know you're aware, but I'm not sure whether the assembled group here is aware that that is equally important.

MR. BOCHMAN: Sure.

MR. GELLINGS: And the juncture of those two are becoming even more critical to us.

MR. BOCHMAN: I think Clark increasingly -- Clark and everybody, increasingly, I think you'll hear the term "cyber physical," as so many things that are physical security protections are becoming -- they have sensors in them, and they do communications, and they have computer chips in them. They are having cyber issues with physical things and vice versa -- the protection of cyber resources through physical means. They're just so interconnected and interdependent now. You'll be hearing that term.

And, yes, it's almost like you could substitute everything that I just said -- automatically global search- and-replace -- "cyber

physical" as applying.

MR. MORGAN: This is two comments. First, there was no differentiation at all in your remarks about the different systems and capabilities that a utility engages in. And it strikes me that not doing some differentiation makes it really hard to figure out -- I mean, it's not clear to me that a one-size-fits-all across, you know, SCADAs, to marketing systems, to everything -- and, yeah, they talk to each other in various ways, but, often, they don't talk that much, or there have been efforts to isolate pieces. And so treating it all as one big continuum, I'm troubled by.

Second, this is not my field, but as a result of some obligations I've developed to run some workshops, I've been reading stuff by folks like Butler Lampson, and Virgil Gligor, and others, and learning about, you know, strategy -- well, any sort of off-the-shelf or commercial software is obviously vulnerable. There's no way you're ever going to fix it. There are ways, of

course, with red/green machine kinds of arrangements or what Virgil refers to as wimps and giants, to at least make kernels that are much safer than the rest.

And so all of what I heard was all kind of protect and defend, as opposed to, how the hell do I get out front, and build at least the most critical systems so that they are less vulnerable?

You want to talk about both of those for a moment?

MR. BOCHMAN: Again, this is just a little tapas- size amount of security, so the level of granularity you seek, I may not be able to satisfy.

But in terms of addressing the different types of systems, one thing, I think, is a general phrase that seems to hold up is, a lot of these different types of different systems used to be protected in large part by isolation. They were stovepipe. They weren't physically connected or networked. And that, in large part, kept them the domains of only their authorized users who passed

through physical security credentials to get through.

It's not an exaggeration to say that the types of systems you mentioned -- whether they're SCADA, or PLCs, or market systems, or business systems -- communications networks, wireless and wired -- but these things are increasingly -- and cyber physical -- increasingly interconnected. And that's happening at a frantic pace. Folks that used to manage control centers -- the operational side, the industrial control system side of utilities -- they used to work their butts off trying to keep IT guys away, hold them at bay -- because they didn't want their stuff to be polluted by touching IT systems. They wanted to keep it knowable and quiet, so that if any variation did happen, they'd immediately see it, and they'd know something funny was going on.

They don't have that luxury anymore. That ship's already sailed, and IT and OT are becoming extremely interconnected. So, that's the bad part.

In terms of getting out in front of the problems --

MR. MORGAN: And who out there is saying this is stupid?

MR. BOCHMAN: Security people say it sometimes, but it doesn't matter. It feels, at least to somebody like me on the security side, that it's a force of nature. Humans are doing this. Humans are building the Internet of Things. Everybody wants their new, smart, interconnected --

MR. MORGAN: So, my reaction, I guess, is maybe we deserve what we get.

MR. BOCHMAN: Okay, but I don't want that tone to overtake the conversation; you know what I mean?

In terms of getting out in front -- I'll keep this part super short -- how do we begin to do something that really, clearly blocks what seems to be, in some cases, a losing battle? Our folks are getting better all the time, in an incremental nature. Our defenses, and our

knowledge, and our awareness at the CEO level and down in the trenches is definitely improving, and there's tangible signs of that.

The counterpoint to that is that the adversaries get better really fast, also. And it's hard to say, on any given day, if we're keeping up with them, or if they're outstripping us. People are thinking about some pretty far-out things, though, that might not have imagined until recently.

And one of the concepts I've heard the last couple times when this topic's come up is the idea that allowing this proliferation of digital technology to go as far as it will -- because of efficiency, because of flexibility, because of cost savings. But at a certain critical point, for certain systems, it is unacceptable to have them be reached and breached. The introduction of analog technology -- things that are completely alien to a digital attacker; you just cannot move it, cannot touch it (inaudible) actually would have to be there to influence the system.

That's future stuff, but that's one approach that I've heard positive to stop this arms race that's been going on -- or at least give ourselves a big boost in our sector.

MS. HOFFMAN: At some point in time, we're going to have to have Carol Hawk come and talk about some of the R&D activities to get ahead of the game -- and probably have a good panel on cyber.

CHAIRMAN COWART: Carl?

MR. ZICHELLA: Thanks, Andy. This is really, really interesting. It seems like one of the defensive approaches that could be taken is to deal with structural flaws in the system. For example, it seems like there'd be a great deal of additional vulnerability in areas that don't have organized markets, where you have many more balancing area authorities than you do in areas that do have organized markets.

It's a thing that enhances flexibility to have consolidated control areas, but it also might be something that would enhance cyber

security not to have so many entry points through which attacks could be launched, especially when you have, like in the West, 38 balancing area authorities. Not all of them are going to be equivalent in their ability to protect.

So, I'm just wondering what your thought is about that, as we, in the West, reconsider how far we're going to go with larger-scale energy markets? We're so balkanized out there right now. Given all the renewables out there, there's a lot of attention being placed on this for flexibility and integration reasons. But I think that there could be considerable security benefits, too.

MR. BOCHMAN: So, you're a Western person, too? I see.

When I mentioned earlier the idea that -- it was in the response to Paul's comment about how a lot of the intelligence right now is not sector-specific; it's very IT- oriented -- and then twisted that around and said, "But that is actually pretty relevant to our sector. We're going to add more OT-related data to the CRISP

system and some of our activities in the future, I believe. But right now, that's the way it is.

I mentioned the idea of lateral movement; you come in through IT, but you're after operational technology. And the skills that get you into IT, by the way -- and the knowledge of internet protocol and certain very common operating systems -- it takes somebody different to know how to mess around on the industrial side. It's a different skill set and different systems that you're trying to overtake.

I would say that, in those large markets you're describing, the concept of -- let's say once you're into the operational technology side of things as an attacker -- that lateral concept of moving -- now that you're in operational on one utility -- we don't necessarily -- how can I say this in a nice way -- it is possible, using certain known vulnerabilities, to move from one utility's operational systems to another operational system -- and, therefore, do some jumping around in that direction, too.

And that's a big concern. And that's something I know that DOE -- I've been part of conversations -- is focused on -- is to try to limit the ability of somebody to jump from one utility to another utility.

MR. ZICHELLA: Yeah, it's a particular problem when you have a lot of seams coordination that has to go on because you have all this balkanization. And now, with the introduction of things like energy and balance markets -- which are a real improvement -- you're having these systems be linked a lot more closely than they were before -- where some of them -- we don't have a region-wide day-ahead market there, but now we're having opportunity for people to really transact much more close to it and in realtime.

MR. BOCHMAN: Sure, sure. And you'll hear some people -- the man and the woman on the street who are dipping their toes in this topic will think, well, will micro grids solve all this, if we have diverse equipment -- if we have more diversity and islandable systems -- make it harder

for attackers to jump? To be continued on that topic.

Oh, there's still more, aren't there? Yeah.

MR. BALL: Yeah, just to make sure we don't get all worked up in a conversation here and assume nobody's doing anything -- I would say, as somebody who bears some of this wonderful responsibility -- now, granted, a large organization -- we spend a heck of a lot on security. I would say the -- from my personal knowledge that, actually, yes, ISAC does quite a good job. I have no hesitancy whatsoever -- and nor do any of my people -- about interacting with the ES-ISAC in fear of it being organizationally associated with NERC. Yeah, for a knowledgeable party, that is a nonissue.

I would also encourage you -- there is -- well, not in public, for good reason -- there is a lot of actually very good peer-to-peer information sharing going on in some organizations. And it's not always just large

company to large company. So, we interact with municipal systems, with cooperative systems, and even those well beyond our traditional service territory through some industry organizations on this particular topic.

And it is true -- I mean, a very large company might find it easier to keep a sufficient staff of highly technical, highly valuable people. And it's harder for a small entity, but I wouldn't assume that, you know, everything's going to pot overnight.

And, Granger, maybe you would be comforted to know that, you know, at least at our outfit, corporate IT is totally separated organizationally from most of my controls groups. And that's just a personal commitment of mine. They'll have to fire me first.

So, you know, just -- and this statistic, Paul, that you read -- which is interesting. You know, statistics are wonderful things. But I would tell you, it shouldn't be a surprise for what we're talking about that a vast

majority of the initiating organizations, as far as the intelligence, is actually branches of the federal government. So, don't be a shocker that the utilities themselves aren't generating information about nation-state activity, okay? I mean, I'm not set up -- I don't have -- I mean, maybe I should apply to be, you know, a spy in another country.

But, you know, that shouldn't be a surprise, that a lot of that initial sourced information comes from people who are actually very good -- and that's their purpose -- at gathering that type of information.

MR. BOCHMAN: That's right.

MR. BALL: So, we have to be careful with fancy numbers and things. But you're right; this is an ever- evolving scenario, you know. And it is -- you know, you can never relax. And so you're right that the companies who take this very seriously never think they've got it licked. And it is a continual challenge. You know, you're talking about -- I chuckled when you talked about

adding analog pieces back in to trip everybody up. You know, I just threw all that stuff in the dumpster to go to digital everything, partially to create Clark's grid of the future, right -- my dear friend?

MR. BOCHMAN: And, also, don't forget, the craftsmen that used to work with the analog stuff who are rendered redundant. You have to go find them again.

MR. BALL: We don't train anybody, you know, how to deal with that stuff. So, it is kind of humorous, you know. Maybe the old is going to be new; I don't know. Maybe that'll be a second career for me, being an old guy. So, I don't want us to get too overly worked up. There is a tremendous amount of conversation going on on the topic. Is it perfect? Absolutely not.

MR. BOCHMAN: Yeah, but the awareness is there (inaudible) a few years that the awareness at the senior levels was lacking, and without that, there wasn't going to be change.

MR. BALL: Yeah, and I would -- I'm very

encouraged, you know, with the Electric Sector Coordinating Council, you know, on the electric side -- it's being held up as one of the most effective coordinating councils. That's largely where the CRISP connection came from.

MR. BOCHMAN: Sure.

MR. BALL: And so there's actually a lot of positive movement here -- not perfect, but positive.

MR. BOCHMAN: And you've heard it mentioned earlier by Carl from PNNL -- the Grid Modernization Lab Consortium has a focus area that's called simply Security and Resilience. And security gives you both things. If you just say "security," you get cyber and physical. And "resilience" is the part that means we know we can't always keep everything out. We know, in fact, that, already, there are things that are inside our systems. Resilience is the acknowledgement and the acceptance of that as an ambient state of affairs.

And how do you want to be? If you

acknowledge that that's the way the world is, how do you want your organization, your mission, and your systems to behave in these various states? If you do the planning upfront, if you go through exercises like the NERC-sponsored GridEx exercise, which is going to be in November, you can get a real, tangible feel for how you're doing, and how you would respond to these different types of situations that not only you imagine yourself to be in someday -- hopefully not, but maybe -- but that you might be into various states at the present moment.

It's a lot easier to sleep when you know you've been doing this stuff, and you're not just hoping and praying that nothing happens.

CHAIRMAN COWART: So, we have just a little remaining time to deal with dessert here so that we can actually go to another place and start appetizers. And we've got three comments up -- two.

MR. BOCHMAN: Maybe just yes/no questions or multiple choice.

CHAIRMAN COWART: Right. So, I'm urging brevity.

MR. THILLY: Quickly, I was going to say some of the same things that Billy said. I think there's been a dramatic change in stepping up of the ISAC, particularly with the CRISP Program over the last year, year and a half -- full physical separation of the ISAC from the rest of NERC, a code of conduct.

And I'm glad to hear Billy say he doesn't have any concerns. I think that's reflected in the fact that the utilities came to NERC, and asked NERC to take on CRISP, rather than do it independently -- which shows, I think, that that lack of trust that was there before is pretty much gone.

The participation in ISAC has gone up every year. I know Pat and her group have encouraged that. I would suggest state regulators could certainly encourage that. And the participation in CRISP is, I think, between 15 and 20 now, and those are some of the largest systems

out there. So, percentage-wise, in terms of facilities, that's very significant -- and is expected to grow or double over the next year or so.

So, there really has been a significant change over the last year and a half that's continuing.

CHAIRMAN COWART: Thank you -- a last word.

MR. LAUBY:: Yeah, thank you -- and, of course, thank Billy, and thank you, Roy, for all the words and the comments. And I can say, from NERC's perspective, as Roy indicates, we have kept that exclusively separate.

And, that being said, I have to say -- and working in this industry for as many years as I have -- the commitment to reliability and the sharing of information in this industry is tremendous, and I don't think that, you know, people hide things in order to avoid kind of a NERC compliance issue. Again, it is separate. We have a code of conduct that nothing ever goes

beyond those walls.

Now, being a technical person, though, I can't help but to take Pat up on her offer on the design perspective, because I think this is really just another disturbance function that we have to design for. You know, I know that there are different ways in which a cyber attack might come at you. The results, though, and the impacts, I think, can be determined as to what's going to really create havoc on your system. And what level do we want to design to? And then what level do we want to have resilience to?

And, you know, folks like Billy can tell you how it (inaudible) have resilient systems when it comes to hurricanes and the responses to serious events on their system, which they don't design for, but they're ready to react to. And I think that's an important aspect of reliability, as well.

So, with that, I thank everybody for (inaudible).

CHAIRMAN COWART: Thank you. And thank

you very much for the presentation and dialogue -- a really excellent set of things to think about.

We're at the end of our afternoon, and I've got Samir, if he would tell us all about dinner.

MR. SUCCAR: I'll be happy to do that. This is Sarmir back here.

In the email you received from Maureen with meeting materials, there was a file called Arlington Map and Directions. It shows clearly that the restaurant -- which is a new location, relative to where we've had it in the past -- is Il Forno, which is across the street from the Westin, around the corner from the Holiday Inn. And if you have any questions about how to get there, my colleagues, T and Andrea, sitting beside me, can help you get there. That's it (inaudible).

Starting time is 10 minutes ago.

MS. HOFFMAN: Then tomorrow, we're starting at 8:00?

CHAIRMAN COWART: We start at 8:00

tomorrow morning.

MR. SUCCAR: That's right -- 8:00 tomorrow morning. We will start with the QER update.

(Whereupon, the PROCEEDINGS were adjourned.)

* * * * *

CERTIFICATE OF NOTARY PUBLIC

COMMONWEALTH OF VIRGINIA

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

(Signature and Seal on File)

Notary Public, in and for the Commonwealth of Virginia

My Commission Expires: November 30, 2016

Notary Public Number 351998

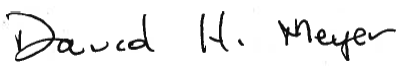
Respectfully Submitted and Certified as Accurate,

Richard Cowart
Regulatory Assistance Project
Chair
DOE Electricity Advisory Committee

5/12/2015
Date

Irwin "Sonny" Popowsky
Pennsylvania Consumer Advocate
Vice-Chair
DOE Electricity Advisory Committee

5/12/2015
Date



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