UNITED STATES DEPARTMENT OF ENERGY

ELECTRICITY ADVISORY COMMITTEE MEETING

Washington, D.C.

Monday, October 15, 2012

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Other Attendees:

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EUGENE LITVINOV
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ELLIOT ROSEMAN

CHRIS SHELTON

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P R O C E E D I N G S

(1:56 p.m.)

MR. COWART: Okay, everybody, I think we should begin.

Good afternoon. This is Richard Cowart, Chair of the EAC.

And, as always in these meetings, we make it clear from the beginning that the sessions are public. A transcript is being prepared, and for that reason it's important when people are speaking that when you want to be recognized and speak you should stick up your card, and we'll call on you and try to keep it in order.

And also, for any members of the public here, there is a registration that you can sign up for the opportunity to address the Committee tomorrow afternoon.

Are there any questions about that procedure or additions that we should make?

MR. MEYER: A reminder for the -- because we are having a transcript made, when you do offer comments or participate in the discussion, identify yourselves, please.

This is David Meyer from the Department of Energy.

(Laughter)

MR. COWART: That's known as a good save, David. We have the great good fortune to have some new members with us today. Whenever I look at the Committee list, I have to admit that I'm really perpetually pleased at the quality of the people and the amount of expertise that the Department has been able to attract to this Committee, and that tradition continues with the addition of some new folks today.

And so, I guess I would just like to give them an opportunity to identify themselves and say a little bit about who they are and their backgrounds. I don't know where everybody is sitting, but we have Paul Hudson, Linda Blair, Dennis McGinn, Chris Shelton and Christopher Peters here.

So -- and I think if we start down here, we might -- it might work.

MS. BLAIR: Good afternoon. Thank you. I'm Linda Blair wit ITC Holdings Corp. Thank you so much for the opportunity to participate and join the Electricity Advisory Committee. I'm pleased to be here today.

For those of you that are not familiar with who ITC is, we are the ninth largest transmission owning entity in the United States. We are the only truly independent transmission company. We have absolutely no affiliation to any market participant. And our assets sort of span across the Midwest, throughout the states of Michigan, Iowa, southern Minnesota, Illinois, as well as development projects in Kansas and Oklahoma, as well as a pending transaction to acquire the high voltage transmission assets of Entergy Corporation. So we are a significantly large player in the transmission space.

And I really welcome and appreciate the opportunity to be here today.

MR. MCGINN: Hi. I'm Denny McGinn, a recovering sailor, having served 35 years in the

U.S. Navy. I'm the President of the American Council on Renewable Energy. ACORE's mission is to help build a more secure and prosperous America with clean, renewable energy.

Prior to ACORE, I've had a variety of jobs in the private sector since retiring from the Navy, including five years with Battelle Memorial Institute in which I had an opportunity to work with many of the DOE labs.

I am pleased to be here among this august group and hope that my experience in the Navy and certainly during the last 10 years -- very, very much focused on all forms of energy -- can add some value to it.

Thank you very much.

MR. PETERS: Good afternoon. I'm Chris Peters with Entergy Corporation. I'm our Vice President of Critical Infrastructure Protection.

And, as Linda said -- alluded to -- I want to echo her comments. It is an honor to be on this group and to help provide some insights from the private sector to help us in these key areas we're focusing on here.

I'm a former Marine, and a lot of the Navy folks I talk to say Marine stands for muscle, a requirement, intelligence not essential. So I always find that interesting.

(Laughter)

MR. PETERS: But I spent a couple years at ICF International and worked with Elliot before on cyber security issues and also spent some time at Grant Thornton as well.

Again, I just want to say it's a pleasure to be on this Committee, and I look forward to getting to know everyone and working with you on these issues.

MR. HUDSON: Good afternoon, everybody. Also, thank you for the invitation to participate here.

I'm Paul Hudson. I run a small investment boutique, also advisory boutique, in Austin called Stratus Energy Group. My ticket to entry here, I think, was punched and where I met many of you is I was a former chair and commissioner in the Texas Commission. And I look forward to working with the Committee over the course of the coming months.

MR. COWART: Chris.

MR. SHELTON: Good afternoon. My name is Chris Shelton. I'm the President of AES Energy Storage, a part of AES Corporation.

I appreciate the opportunity to serve and look forward to serving on the Storage Subcommittee. My background is -- most of my career is in AES. I've worked in retail electricity, telecommunications and information technology. So I look forward to participating on the many facets of the Storage Subcommittee.

Thank you.

MR. COWART: All right. Thank you. One heads up about -- that's everybody for whom this is their first meeting, right? All right. Anybody else which is to make an introduction who hasn't? I think everybody else has been here before. As the members of the subcommittees know, the subcommittees have been incredibly active in the last -- in the period since our June meeting, and we're going to be seeing the fruits of all that labor put in front of us this afternoon and tomorrow. There's quite a lot of business in front of us. So we're going to proceed pretty quickly through the agenda.

For the new members, you've probably received the David Meyer introductory lecture. So I won't repeat much of it except simply to say that we really look forward to your active participation on the subcommittees and hope that you like writing because that's the way it works.

So, welcome and let's get going. I've been informed that Pat Hoffman is unable to be with us right this minute but will join us soon. But Lauren Azar is here, and I think we should just skip to our part of the agenda.

MS. AZAR: Fantastic. Thank you. Good afternoon, everybody, and delighted to be here. I was asked to discuss the kind of work that I'm doing on transmission institutional issues at the Department. So let me go through the initiatives

I've been doing over the last 16 months. But who's counting?

As most folks, I have been -- know that I have been involved with the Rapid Response Team for Transmission. The RRTT is currently doing -- I would say we've got two different modes going on right now.

First of all, back in May, the -- there are nine agencies that are a part of the Rapid Response Team for Transmission. All of those agencies are -- have some core participation in the evaluation of federal transmission applications.

The principals of the nine agencies in May adopted a number of systemic changes that they would like to see the agencies implement, which are intended to streamline the federal permitting process. It was a watershed as far as getting the principals to sign on to these systemic changes. Now, of course, the devil is in the details on implementing those systemic changes. So we are working on that.

The systemic changes include things like creating a dedicated national transmission team, pre-application processes, application tool kits, trying to get cost recovery for all of the agencies. One of the challenges is some of the agencies do not have a way to pay for increase in staffing for essentially focusing on transmission projects, so taking a lot at cost recovery and how we can get that done. Those are just a few examples of what are included within the systemic changes.

But, as a parallel process to that, I think many of you know that the DOE back in 2005 was given a significant amount of obligatory action as well as discretionary authority under 216(h) of the Federal Power Act. We have been working through a number of different drafts of rules implementing that authority. We are currently working on an entirely new draft that would speak to many of the comments that folks here provided to us based on the last NOPR.

And we're in the process of negotiating

that rule with the other agencies before we actually formally decide that we're going to release it into the public domain for comment. So we're still early in the process, but we've got a nice rule at least ponied up for discussion amongst those nine agencies.

Those are the primary activities in the Rapid Response Team for Transmission.

DOE, the Office of Electricity, is actually hiring some staff to implement its authorities under 216(h), and so we're looking forward to getting that staff on board. I think the positions are on the street right now.

I don't know if you know, David, but there are likely some openings.

There's Pat. Pat will be able to answer that question.

Hi, Pat.

MS. HOFFMAN: Yes and no.

MS. AZAR: All right. With regards to 1222, which is another component of the DOE's authorities that were provided to the DOE, that was also provided back in 2005.

This Committee is actually -- I believe either has or is about to take some positions on DOE's implementation of 1222.

The last time I was here I told you guys that we were about to take action on it, and I got the sense that everybody was saying: Yeah, right. It's been seven years. We'll see what happens.

Well, indeed, we did take action. Back in April, the Deputy Secretary indicated that for an application we had received under 1222 that it was to the point that the project was mature enough that it was to the point that we would proceed into the NEPA analysis of that project. That is a clean line application for a DC line going from western Oklahoma into Tennessee. So we are now embarking on the NEPA analysis for that project.

As a part of our evaluation of that application process, I can tell you we learned a lot about DOE's implementation of the 1222 law, and indeed, we learned that the guidance that we had put out in the Federal Register -- oh, I'd say 2 or 3 years ago -- needs some improvement because it doesn't necessarily track well with how applications are going to actually come into us and how we should be evaluating them.

So we are currently, right now, in the process of figuring out a new way in which to evaluate the 1222 applications, and we'll be -- actually, we're going to come to NARUC, as an aside, and talk to the commissioners about it, and we're holding a listening session in Tulsa on November 29th on a potential new process there.

So the good news is we've done -- we're in the process of moving forward on NEPA in one, and we're coming up with a process that will -- should streamline our evaluation of future applications.

And there is another application, another clean line application, that's pending right now. They have indicated that they don't want us to move on it quite yet, but when they are ready, they will be submitting an amended application.

We're also discussing possibly a project in the Western Area Power Marketing Administrations' service territory under 1222.

So, anyway, for those folks who are going to be in NARUC on November 13th and you want to comment on 1222 and our process, please come to the session we're going to have. It's late in the afternoon.

Lastly, let me talk about -- well, I guess it's not actually lastly -- the congestion study which David Meyer is leading as far as the preparation of it. We are working through the 2012 congestion study. It is hopeful that we will release a draft before the end of the year for public comment, and we are looking forward to hearing all of your thoughts on this congestion study because it is different than prior congestion studies with regards to how the report is going to be analyzing data and setting forth the Department's conclusions.

Lastly, with regards to the Power

Marketing Administrations, they're -- as you know, they own quite a lot of the transmission infrastructure in the United States. We are currently working with the PMAs on a number of different issues. We're focusing a lot of our efforts right now with regards to Western, and there is right now a joint team of experts that are drilling down and will be coming up with a group of recommendations on how Western can improve its services, mostly focused on transmission services and transmission assets.

Those recommendations should be posted in the Federal Register in early November with -- and that team is hoping to get its final recommendations off to the Secretary by the end of the year.

So that's all I've been working on. Any questions?

MR. COWART: It takes me a second just to relax after listening to all of that.

I do want to open it up to questions, including sort of -- you can even ask her a question that includes go back and say that again.

Mike.

MR. HEYECK: I just wanted to state that the addition of Lauren -- as advisor to -- senior advisor has been very helpful to our industry, and I encourage her to get it all done by next Thursday.

MS. AZAR: You guys are way too easy.

MR. COWART: Thank you, Lauren. Next on the agenda will be Anjan. You can report on Grid Tech. Pat's deferring to you for the moment.

MR. BOSE: I am going to use the slides.

(Pause)

MR. BOSE: All right, good afternoon. This is the second time I think I'm talking about the Grid Tech Team in front of you. So -- but several of you are new, and so you won't know this. But the previous people will actually recognize some of these slides, and I will be repeating some of the things.

And one of the reasons to repeat it is because I keep getting asked by the same people over and over again what the Grid Tech Team does. So -- and this is within DOE.

(Laughter)

MR. BOSE: Just to give you an idea, the Grid Tech Team was set up probably about a year ago, or a little bit more than, that to try and coordinate a lot of the work within DOE that is done on the grid although a lot of it is done within Pat Hoffman's office. There is quite a bit that is done outside of Pat Hoffman's office. And the whole idea was to try and see if there is some overlaps in these things, gaps in these things and how these things can be coordinated better.

So then, it starts from -- the whole idea, of course, is that we do a lot of work on components of the grid, and -- but putting all the components together doesn't make the grid. Or, another way to put it is many of the people who are working on particular things like wind or solar are finding that when they're connected to the grid there are certain constraints on doing that.

And so, what should the future grid look like? So there's -- and you can read that as much as I can, but the whole idea is to have a cost effective electricity system, seamless, and from generation to end use, taking into account things like clean energy demands and the capacity growth, while also allowing consumer participation and electricity use.

So what are the major things that are happening in that field? Well, clean energy. I think you can see that there's a lot of need for renewables but all kinds of clean energy as well. On the distribution side, there are huge amounts of changes taking place and including customer demand side management as well as electric vehicles being anticipated in large amounts, distributed generation and so on.

So how do we design this system where it's holistically efficient and reliable and secure?

So the last line on that slide is probably the key one, which says that ultimately you've got to have a grid that's reliable, secure and resilient.

So, on the left-hand side of this slide, you see the different things that are changing, that are kind of the trends, and changing the supply makes the demand side is changing. The complexity of the grid is changing, and all -- but on the other hand, there's a lot of technology that is going forward, including things like computers and communications and controls and sensing that allow you to do more things with the grid.

The downside of all that new technology, of course, and especially in the IT space, is that it creates another set of vulnerabilities. I mean, it's not just storms that bring down transmission towers. It can also be hackers who can bring down your computers. And so, there's a bigger set of things that can go wrong even though as you increase the ability to do better things with the grid.

So, if you look at what we're doing here in the grid modernization strategy from the Department of Energy, we have -- again, on the first green box there it says RD&D Activities, the Research Development and Demonstration Activities. And that's, of course, most of what DOE does. So that's sort of the bread and butter, so to speak, of DOE trying to bring out the viable technology solutions.

Now one of the things that all of you can appreciate is that we have -- one of the barriers ends up being institutional issues, not just technology, that just getting technologies invented is not enough. And we'll talk a little bit more about that.

So the other the other green box in the middle says Initiatives there, and what we're trying to do is try to understand and see whether DOE can engage in some of these areas where institutional and technologies issues kind of intertwine in a way where both have to be solved to get across the barriers.

And then, of course, we have the ability to work directly with various parts of the country, the regional activities and regional engagements.

I mean, I think most of you are very knowledgeable about how the different PUCs, the 50 different PUCs, engage in the grid activities and how the different regional entities, planning entities, transmission authorities and so on, engage in this space.

So what are the things that we are looking at doing the critical roles that we can play as DOE -- is to convene the diverse stakeholders. I think the EAC is probably one of the ways to do that. The information exchange, the aggregator and disseminator from both RD&D and the strategic planning workshops and so on can all be part of that. And, of course, finally, the technical expertise and analytical capability goes without saying for our RD&D operation.

As I said before, the research, the technical research, is one big thing. The initiatives, what we're calling initiatives, are the things we're trying to do where we engage different stakeholders into getting into the more institutional challenges and then regional engagements to try and move forward some of these things.

So, now going back to the system viewpoint of this thing, see -- in this slide, you can see the generation, transmission, distribution, end users -- those vertical boxes -- are the obvious ways people think of the grid as connecting the transmission and distribution, connecting the generation to the end users.

And that's all fine, but where does this -- what is the grid?

What is the system? What are the issues of the grid? And how do we differentiate? We have spent quite a bit of time within the Grid Tech Team kind of talking about this. And it's those two boxes that are horizontally across on those -- that whole picture. I think that's where the Grid Tech Team comes into play -- the efficient, reliable and secure system operation and cost effective system planning and expansion.

Okay. We'll talk a little bit more about this. So here's one way to kind of divide up the things we're doing. Okay. You see the three circles over there. The red circle, we call understanding, and that has to do with the models, the simulations, the physics of what the grid does. This is different from the physics of just the storage device or the mathematics of just the power flow solution. It's the whole picture. It's a simulation of all of those devices put together. It's the modeling of the whole grid with all the pieces.

So that's what -- to understand that this is the knowledge part of it, this is the R&D required there, is to look at the physics, the math and so on.

The visibility, the green circle on the right -- the visibility of it is just knowing. Can you use what is happening?

And that has to do with sensing. That has to do with SCADA systems, with EMS, with phasor measurement units, with smart meters, with how do you look at the grid. How do you see the grid? How do you observe the grid?

What makes it observable? What makes it controllable?

So, to know what is happening. So this is the informational part and the -- and this is where we are getting huge strides in computers, communications, sensing devices, controllers. Right.

So those are the things that make it a lot more flexible, so to speak.

And then, finally, of course, the flexibility of the grid itself or the physical part of the grid -- this is where you have the usual things of transformers and transmission line and distribution lines and protective relays, and so on and so forth.

So those are the different pieces of the puzzle that come together in terms of our R&D plans. So this is our way of looking at what the R&D should be divided up and pursued.

We put on the side, on the right-hand top corner there, the institutional factors of markets, regulations, policies and standards which all impact the actual implementation of any of these technologies. So that's sort of the how we look at the grid.

And what are we doing in the near term? So, two sets of things. One I said was the initiatives, and the other one was R&D activities.

So, the initiatives. The main initiative we've taken on is this idea of how to improve situational awareness and data sharing. Okay.

And one of the things that came to us sort of in a sequence of things -- you know, we were talking. We sponsor the North American SynchroPhasor Initiative, which is looking at all the PMU data and what to do with it, and they're running into issues of how to exchange this data.

The blackout report came out from the Southwest blackout, and that pointed out all the problems of not enough data being -- real-time data being shared among the different utilities so that the operators, many of the operators, were unaware of what was going on in the system.

So the whole question of exchanging data from planning to operations to markets to day ahead planning -- those are all issues that we think have both institutional and technology aspects. And I'll tell you in a minute what we did there.

And then, on the R&D activities, we already have had a distribution system workshop to talk about a road map for R&D in that area, and then we're about to have one on the transmission system.

The distribution workshop was held December 24th and 25th. We still -- so the whole idea was to bring together people who work on distribution systems in one room. We had, I think, 100 and some people there, and the idea is to come up with an R&D road map.

What we did there, I think, will probably interest you a bit on how we structure that workshop because what we did -- we had breakout sessions, which is a sort of normal way to run these kinds of workshops.

The first breakout session was broken out into this list of things on your left -- the variable renewables. So we had the wind and solar people in there, the dispatchable renewables, the fuel cells and other dispatchables. The smart grid technologies were in there, the micro grids and so on. The electric fuel cells and fuel cell vehicles, the electric vehicles people -- the buildings was another one, and energy storage.

So -- but these groups were very comfortable among -- within themselves because they all knew each other. And they sat around, and they said, what are the big barriers to getting more of these things onto the grid?

Okay. So then they knew exactly. So we got lots of very good ideas from that.

And then, in the afternoon, we mixed them all up, and we said: Look at it. We don't want you to talk about what you need to do to the electric car but talk about what you need to do to the grid that will make you do more with the electric car.

So how do you make large amounts of electric cars visible to the operator?

What do you need to know to be able to model the behavior of large numbers of electric vehicles being charging and discharging in terms of system operations over a day or a weekly cycle?

What do you need in the grid so that these electric vehicles can be charged at the right time?

So what kind of flexibility does the grid need? And that got everybody talking and finding it rather hard to identify the barriers when you start looking at your piece of expertise in the context of everybody else's.

So I don't have here any pithy outputs of this thing. We're still collecting all of the outputs. It's been less than a month. But we will have a report out of that as to what we think the grid-related R&D should be done in terms of the distribution.

One of the initiatives, as I said, was data sharing. So we had a different meeting on October 5th. This was a small meeting, about 14 invited, industry leaders. And the people involved with that were the Secretary was involved, Pat and Lauren and myself and Jay Caspary and so on, from DOE.

And these were all industry leaders but with intimate knowledge of the data sharing issues. So some of them were from EMS, from phasor measurement, others from the planning side of the companies or from the ISOs, and so on.

So, here I can tell you -- I mean, this was not supposed to be a big report or anything. This was supposed to be an informal half a day's worth of meetings and discussing what needs to be done here, what are the institutional issues, what are the technical issues, and so on.

So one -- so a couple of suggestions that came out of it were that data exchange is necessary for situational awareness, blackout prevention and adequate planning. Now this doesn't surprise anybody, that that was one of the thoughts, but when you're running a large grid the data exchange between the owners of the grid is an absolute necessity.

The question that really needs to be worked on is: What are the modalities of data exchange that are needed for planning, for operations, for markets, for day ahead planning?

So what are the entities that can decide the kinds of formats and protocols and processes that need to be in place to be able to do this data sharing?

And so, that's something that I think DOE has offered to help in any way the industry to go ahead and start moving on this.

And, finally, we're going to have a transmission workshop November 1st and 2nd. This is going to be, again, breakout sessions and so on. We're in the middle of planning this -- the actual thing. We expect about 100 people again, just like the distribution workshop. And this is to come up with an R&D road map for, again, looking at it from the grid point of view.

So, finally, this is my last slide. I'll leave you with this. My mantra has been for the last six months I've been here -- is Systems, Systems, Systems.

And so, here are our three circles. The visibility, understanding and flexibility are the things we need to understand about the grid.

Thank you.

MR. COWART: Thanks, Anjan. Don't go away in case there are questions.

Are there questions or follow-up on this presentation?

Yes.

MR. BROWN: Merwin Brown with the California Institute for Energy and Environment.

Anjan, on one of your slides on the distribution, where you had that list on the left that you broke out the first -- yeah. Those are kind of apples and oranges lists because some of those do things to distribution and some things do for the distribution. Did you see a distinction made when these people got together to work on things?

In other words, I hear people make the comments, as an aside, that smart grid technologies are the problem. I always thought of them as the solution. Yet, others are out there are seen by the grid as a problem, like variable renewable.

So did that distinction come out in this list, in the results?

MR. BOSE: Well, yes, in the actual feedback we got, of course, they could see the distinction, but some of the smart grid technologies -- but the reason it was divided up that way is very simple. That's the way our programs are divided up within DOE. So we had the stakeholders right there.

MR. COWART: Can you go back one slide before that? I'm just -- actually, keep going because I'm looking for the goals. Oh, it's quite a ways back. It's back to the beginning. Sorry.

I apologize. There we go. Reliable, secure and resilient. Was it also part of the thinking of your process that what you're looking for is a grid that is reliable, secure and resilient while delivering some other goals, namely, efficient, delivery of power across power markets that can lower costs or, as you say up at the top, that one of the goals is to accept that a higher penetration of renewables is necessary to meet national objectives?

Is there something more to it than just, well, we want the grid to work and we want the grid while it's delivering these other things?

MR. BOSE: Yeah. I mean you raise the main issue we struggle with. The grid is everything to everybody, and so to try and come up with some language that fits on a page or, rather, a PowerPoint slide makes it difficult.

So, the question is, where do you put these things, I guess.

So, yes, it does include that. In fact, efficient -- efficiency shows up in one of the pictures, I think, that I showed you. Cost effective system planning and expansion shows up. Efficient, reliable and secure system operation shows up.

So, yes, you're right. We could write this in different ways, and I think if you look at many, many reports that are written about this area you'll see people dividing up and using different language to do it.

MR. COWART: I'll try to take them in order. David.

MR. NEVIUS: Dave Nevius from NERC. I was one of the folks at the October 5th meeting Anjan mentioned, and maybe others want to comment on this too. But in addition to talking about the need to exchange data, there was also some suggestion about DOE support for developing the applications for system operators as to what the data means.

It's fine to have PMU data with 30 scans a second, but unless we can put that into a form that the operator knows what he's looking at, it's not very useful. So a common information model and structures for exchanging the data are very important but also equally important is the development of applications.

MR. BOSE: Yeah, that's an interesting thought, David, because it came out this way.

You know, people pointed out that PMUs are going in, in a big way, but the biggest barrier is that there are not enough applications to justify the PMU installations. On the other hand, to make the applications work, data sharing agreements and processes must be in place.

So we have this kind of problem of the chicken and the egg, and we have to kind of ratchet it up together.

MR. COWART: I didn't catch who is next, but why don't we just start with Dian?

MS. GRUENEICH: Thanks. Dian Grueneich, strategic consultant and former commissioner with California Public Utilities Commission.

Two quick items. One is on the cost, and it strikes me that that's going to be a very difficult item. I understand that it sounds like the product out of this will be a proposed R&D plan for DOE on both the distribution side and the transmission side.

And because of the way our electricity system is organized in the United States, the approvals for passing on the costs of all these components are generally either at the state commission level when it's looking at the distribution side, and each one of that is very, very specific to the state's own rules.

And then, the actual utility system, if you're in an organized market, then the transmission side costs will obviously be through the organized markets. If you're in an integrated state, then that too will go to the state commissions.

So when you talk about looking at this cost effective manner, if you've cracked the bullet -- cracked the nut on what on earth do we possibly mean in the context of how we're approaching the U.S. or how are people thinking about it because what's cost effective for one part of the country may be very not cost effective for another. And what does that mean in terms of the technology development that you need to have?

And then, real quickly, my second comment was that in California we're doing a re-look at the use of the R&D monies, and the folks involved are submitting triannual investment plans. And one aspect of R&D that is being called out is not just the technical side but the process side and the institutional side.

And I don't know if DOE can play a role in this, but I've been doing a lot of thinking about this and writing in this area, where there is sort of an assumption that our current institutions at the state commissions, at the wholesale markets, everything else are going to be able to rise to do this.

As a former commissioner, I have complete confidence in everybody, but there's a question to be asked, I think, which is: Is this really going to be feasible, or at the end of the day, despite tremendous efforts on R&D, without addressing and actually changing some of the institutional sides, are we running into a problem?

MR. BOSE: Well, let me just say that costs and efficiency and things like that are always part of any R&D plan. So I think they are obvious ones.

I think it's more difficult when you're looking at it systemwide. That is, it's easier to find out what the kilowatt value -- the value of the kilowatt of installed PV -- is and see what it would be if the technology changes. It's a lot more different when you're trying to put together a whole system where you've got so many different variables.

So the tools needed to develop to do that, for example, for planning tools, I mean that's about what the cost of what the plan is going to be of new transmission lines or new control centers or whatever. The tools needed to analyze that have to be in place.

So the planning tools need to get better. It needs to be able to handle things like what happens if you put a lot more PMUs in addition to what happens if you put in a lot more underground distribution lines, for example.

But on the other question, I think -- about the institutional side -- we, of course, end up talking about it a lot. Whether an R&D approach can handle it or not is still an open question. About the institutional issues, I think there are some parts that can be R&D.

But we have taken the approach here -- as I said, these initiatives are essentially stakeholder talks. You know, discussions on how to get around, get over, the institutional issues.

And this data thing we have taken up in the beginning is because we felt that there are several parts of the industry that are already feeling it. The people who are dealing with PMUs, we are hearing from. People who are trying to make sure that they have the situational awareness in the control centers, we are hearing about.

So the data issue is coming. I mean, we don't know how to tackle it necessarily, but we are at least starting the conversation to do it.

MR. COWART: Bob.

MR. CURRY: I guess I'm sort of -- this is Bob Curry from Curry Energy, which is a tautology for those of you who are paying attention.

Sort of piling on to Dian's point, the mantra for regulators -- and I was for six years a New York commissioner -- is safe and adequate service at just and reasonable prices.

Your target audience for anything that comes out of this is either state commissions and/or RTO ISOs.

The RTO ISO system is -- and Cheryl LaFleur is not here to listen to this -- notoriously difficult to pin down when it comes to transparency and costs and how they're allocated among the various rate-paying groups.

The states, however, as Phyllis and I pointed out in something that's not yet published

-- but hold on, by next March it will be -- point out the need for M&V, measurement and verification for whatever is done.

So I would endorse what Dian said. I would suggest that as in any marketing exercise, which this ultimately is, that you start with your target audience and find out the language that speaks to them. And before someone embarks on something that might subsequently be seen as imprudent by the next commission that comes along, or even by someone changing their mind on an existing commission, that you have as the end product of your efforts a deliverable that speaks to how does this make things better.

Now, in New York, we manage to spend a half a billion dollars a year on energy efficiency and other things that don't have a bottom line return, that don't pass a collective M&V test, because we realize that this is an art and not a science and it takes a while to get to the scientific end.

But unless you approach this -- because

I've seen this in the Eastern Interconnect. I've seen it in a lot of things that happen in this industry -- and I'm obviously not from this industry -- where very many good, careful, considerate, thoughtful, deliberate people go out to do a really good job on something, but they don't think about what the deliverable is and to whom it's going to be delivered.

So I would simply -- I was hoping that you'd call on me first instead of Dian, but at any rate -- echo what Dian said because at the end of the day this is the intersection of policy and politics.

And we -- I was formerly -- I'm a recovering regulator. We're responsible to a rate base, and the rate base gets to raise certain questions about what's going on. Unless you can prove it out or accept the premise that this is good for the country and articulate that in some way that various stakeholders who decide who's going to pay for this can hold on to -- and some of these people will have something to say about that -- that it is a worthy but not necessarily a completely effective approach to some very difficult problems.

MR. COWART: Paul.

MR. CENTOLELLA: Paul Centolello with Analysis Group.

MR. CURRY: Also a recovering regulator.

MR. CENTOLELLA: Also a recovering regulator, hopefully, on the way to recovery here.

It strikes me that in the discussion around visibility you have touched on three really quite distinct and different types of issues, each of which has a different audience and a different kind of problem statement. And I'm not sure what the combination of things was that came out in that meeting.

One is, you know, you talked about format. You talked, David, about a common information model. I mean, these are standards questions. These are questions that are normally taken up in standards development organizations or, if it's appropriate, maybe the Smart Grid

Interoperability Panel. These are technical kinds of questions. There may be new standards that are required, or extensions of existing standards. And if that's the case, you should be identifying what those standards gaps are, and there are processes that can be put in place for doing that.

I heard also there is an institutional kind of question, you know much like the IPC took up, and that may be an appropriate model. What goes on in RTOs may be an appropriate model.

But that involves -- it involves regulators. It involves RTOs. It involves a totally different set of actors from the data and standards question.

And then, I heard also, you know in David's remarks, that there is an application development, more of a strict R&D type problem, which is a problem really for both vendors in the space but also for DOE's R&D labs and R&D programs.

And I think you really ought to be thinking about this in all three of those ways, depending upon what the needs were that were identified rather than thinking about it as one problem because I think it sounds like a combination of problems to me.

MR. BOSE: Can I just clarify that a little bit? In the meeting that we had -- because it was more of an initiative, not an R&D thing, that all of these issues came up because we were trying to identify what -- exactly like you said, where are the barriers here?

So, on the other hand, I should point out that on the R&D side there is -- I mean, DOE is doing a lot of R&D on the applications. In fact, many are being even tested right now and demonstrated.

See, we sort of keep feeling that our R&D side is moving ahead without taking care of some of the -- or not knowing whether some of these institutional issues will ever be fixed, in which case we're sort of going down the wrong path.

And this is where we are doing this

other kind of discussions, where all three are kind of mixed up. Or, even more. Maybe it's five or six of these things that are mixed up.

MR. CENTOLELLA: I obviously wasn't in the meeting. So I don't know kind of what barriers people identified. But you know, you talked about three different kinds of problems, and you need to figure out where is the real barrier and where do you need to leverage.

MR. COWART: Thank you. Gordon.

MR. VAN WELIE: So, Anjan, I was wondering if I could help in the following way. So I was going to sort of restate the premise here and see whether you agree with me.

As I understood this, this is essentially what I'd call a systems architecture vision of the grid that sort of looks at how does it, as an organism, interact amongst the various components and not a recipe for saying one has to invest in this particular kind of technology in this area or that kind of particular technology in this area.

And really, it's about trying to bring some sort of coherent effort to the R&D efforts that DOE already has underway in a way that these technologies can interact with each other in a sensible way.

So what I hear around the table, I think, are sort of natural concerns that people would have, which is:

How much is this all going to cost us? Are we going to be forced to sort of implement certain types of technology? Are there not sort of policy considerations? I think all of those are constraints ultimately on the deployment of technology. My understanding was that what you are trying to do here is create a blueprint for an R&D effort as opposed to deploying anything out in the field.

Am I correct in that?

MR. BOSE: I think your premise is right. Now, on the other hand, there are things being deployed just because of many of the stimulus projects and so on. People are having field experiences that are being collected right now.

But the whole idea is -- yes, your premise was right. The whole idea is to try and get the R&D focus.

MR. VAN WELIE: I guess I would view what's been deployed up to now as experiments.

MR. BOSE: Yes.

MR. VAN WELIE: Pilot projects. As proof of concept. It's not sort of wholesale deployment across the entire industry.

So I would imagine that DOE is going to continue to want to invest in R&D to sort of move the ball forward in various areas within the broad technology space. And what you're looking for is coherence amongst those efforts, and it would provide some kind of blueprint for the industry to be used if it felt that it made sense, if it was cost effective.

MR. BOSE: That's absolutely right. But the way -- the Grid Tech Team has a slightly broader view of this than, say, the people who are trying to solve the photovoltaics question. You know, their focus is very much on how to get the performance of the photovoltaics up and the costs down, okay, whereas things get a little more broader when you're looking at it from the grid point of view because we have no idea how much photovoltaics we're going to have in 2020 as opposed to natural gas or anything else.

So this is where the resiliency of the grid, the ability to handle different ways of the grid, comes in. And that's -- we're kind of focusing on that part of the R&D.

MR. COWART: Merwin, I'll defer to you. Go ahead.

MR. BROWN: Thank you. Merwin Brown, California Institute for Energy and Environment. Let me get this closer. I don't know whether this helps or even if it's correct or not, but if we're looking at the place to have the most effective R&D to handle -- to attack these institutional issues, I look at it this way.

You've got two fundamental costs that

you've got to worry about.

The one you mentioned is the cost of the commodity or the product. In other words, I put an investment in, and I generate some electricity, and I sell it. That's pretty well known. There are some unknowns, but it's pretty easy to get your arms around it from a regulator point of view.

It's the cost of no electricity is the one that's tough, and that's the one that's related to reliability and resilience. Fundamentally, it's an insurance question. How much investment are you willing to make to prevent a problem down the road that may never happen?

And there are probably some things you can do in the research arena to try to put some bounds on that. They translate to actuarial tables.

But the point is you collect lots of data, and you analyze and begin to find patterns and cause and effect responses. So it does begin to bring some -- what's the word I want to use?

Ability to quantify some of this uncertainty that comes from the cost of a no-kilowatt hour.

MR. COWART: Anjan, I'm going to return to the question I think I began with which -- and push you a little --

MR. BOSE: The answer, obviously --

MR. COWART: Push you a little harder on it. Well, it seems to me -- and I just am looking for an articulation from you or perhaps from Pat -- that the Department could be doing all this work to facilitate the R&D that would help to create the grid that could do a variety of different things.

And you could have in mind a grid architecture to connect up a large number of central station plants. Let's say the nuclear -- the next generation of nuclear power plants or connect, alternatively, huge wind farms in the central U.S. To the East Coast, or something like that.

Or, you could say, well, what we really envision is a grid in which there will be a much greater penetration of variable renewables. There will be a much greater integration of distributed customer response. We're going to -- we know that going forward we are highly likely to see a lot more electric vehicles, et cetera, et cetera.

You know, a different architecture to facilitate the evolution of a different vision.

And I guess my question is are you pursuing -- when you sit down to say this is how we're organizing this work, are you entirely neutral as to those futures, or do you actually have in mind an architecture that you kind of think, well, that's really what's coming and so we better prepare for that?

MR. BOSE: I think the latter. That is we -- saying that we're neutral to the future is probably not the right way to say it, but we have to be able to handle whatever the future brings, which is -- so -- and that's the issue.

I mean, you know, let me put it slightly in a more concrete way. Each group of people that are doing R&D in certain areas, they actually have

R&D, say, on what is the penetration level that the grid can handle for wind. All right. And we have these numbers.

But it doesn't matter because suppose you came up with that 80 percent wind can be manageable by doing certain heroic things, but 80 percent of wind may or may not ever come. The question is we have to be able to handle the combination of things.

And the example I always put out is five years ago none of us would have known that the natural gas industry is going to be the big thing for the next five years. And so, the question is, what then?

Now that has certain impacts. Just because you're going to have a whole bunch of airplane engines running electricity, producing electricity, you're going to have a lot of different ways that the grid is going to perform in both your markets, the way it does demand-response, it does frequency control, voltage control, all of those things.

And our question is, do we have the tools to even analyze these things that the future is going to bring?

Do we have the models, the analytical tools, the computer systems, the computer systems to operate these kinds of tools?

Do we have the -- are the PMUs' data going to be available in a way that we can read and calculate things that will let us run this system efficiently?

So, you see, what we're trying to say is some of these things are important, that we develop these tools, these analytical capabilities that are needed, these visibility capabilities, the sensing and the control capabilities that we have to put in to be able to handle these.

MR. COWART: Any other questions?

MR. PARKS: Can I comment on that too and just to reinforce?

I think there are a number of uncertainties about the future, and we want to recognize that and really identify within certain parameters. But I think there are also some certainties that we ought to make sure we remember.

And a couple of those, just to throw them out there and not be too obvious -- there are probably going to be wires to everybody's houses. So we're going to have to think about distribution in the foreseeable future. That's going to have to be dealt with. Right?

That's not going to go away. So it's something we need to deal with.

Costs are going to matter. And so, if you start adding up the incremental costs -- to Dian's point or in Robert's point earlier -- of smart grid plus electric vehicles plus cyber security plus everything else, are there ways we can look at this holistically in order to get that price tag down, knowing that we're going to have to invest in this system because of its aging structure, because of the new requirements that we're putting on it?

So, how do we contain costs within a

system that we understand the number of variables in play?

And I also think that we're going to be faced with regional differences for the foreseeable future. So we need to think about how do we do this and how do we have -- how can we, from a national standpoint, help the nation, recognizing the world that we live in, both from a regulatory and institutional standpoint and from a technology standpoint?

And that's how we're trying to come at this and capture the whole picture, and it is difficult. And I think it will remain difficult, and the best thing we can do is continue to communicate about it.

Thank you very much.

MR. BOSE: Thank you, Bill. I should recognize that Bill and David and several of the Grid Tech Team members are here; Kerry and Caitlin at the back.

And we have about something like 25 people on the Grid Tech Team, and we've been working pretty hard at this. And I should -- I get to talk up here, but actually there's a lot of people working on this for the Department.

Thank you.

MR. COWART: All right. Thank you very much, Anjan. All right. Pat is here, and now we're going to hear from her on her view of where we are and where the Department is going.

MS. HOFFMAN: I'm just going to pick up where Anjan left off.

First of all, thank you, Anjan. I would like to thank all the newcomers to the Electricity Advisory Committee. First of all, thank you very much for joining us, and I look forward to your input in discussions.

I'd also like to thank the returning members to the EAC as well.

Just so you're aware, the reason that I value the Electricity Advisory Committee meetings is because of the constructive discussions. I feel this is a forum where we actually can debate issues in a very technical, professional and constructive manner, and really get at the heart of the difficulty when we talk about the electric system, the differences regionally, the difference in its structure and makeup, for the system and how the system should be the operate. And this forum and this discussion really get to the heart of some of those issues.

And so, the topics that we actually have coming up later and tomorrow will continue to investigate and address some of the difficult issues that we need to address.

One of the things that I did want to bring up to you all is we did do a slight reorganization within our office. Some of you may have heard about it. Some of you may not have heard about it. So let me put the questions to bed a little better or bring up some discussion here.

And what we did was we created two new subdivisions within our organization. So we have the Office of Electricity Delivery and Energy Reliability.

And, no, I could not change the title of the organization although I tried. I wanted to shorten the name, but apparently that's attached to the definition of the Assistant Secretary. So it takes a presidential declaration to change the name of the organization. Learned that lesson.

Anyways, what we did was wanted to highlight different aspects of our organization and bring it out prominently, and we can discuss this further later on during the break.

But first of all, we still have our R&D Division. We've renamed it Power Systems -- Power Engineering Systems, Research and Development. Wanted to really clarify that we wanted to work on systems viewpoint and look at the applied nature of the electric grid, so we just renamed our R&D organization to bring more clarity.

Our Permitting, Siting and Analysis Division we renamed as National Electricity Delivery Division. And the reason we did that was to try to bring in more of the policy and larger-scale issues that we wanted to address from that point of view, not just the activities that we work on, which is permitting, siting and analysis.

We separated out and created a new organization that's looking at the Recovery Act projects. So we call it the Smart Grid Investment Program.

And I do apologize that I did not realize it had the same initials as the Smart Grid Interoperability Panel, but this is life. It's the smart grid.

But what -- the reason we pulled that out was it was very hard for us as an organization. The Recovery Act takes a lot of time and effort from our staff's point of view, and it was needed to pull that out as a separate organization so we could continue to concentrate on what should be some of the research issues, what should be some of the policy issues and institutional issues. And the Recovery Act activities were overwhelming all the work within the organization.

We still have our Infrastructure Security and Energy Restoration Division. That is the same as it was before, looking at the resiliency aspects of the energy sector, providing our emergency response activities and a couple other activities with coordination across the federal government.

The last organization that we created was a -- let's see. It's EIMA.

SPEAKER: Electric Infrastructure Modeling and Analysis.

MS. HOFFMAN: Thank you. Electric Infrastructure Modeling and Analysis.

We created a new organization, and the purpose of that organization is to get at some of the issues that we started talking about here, which is the value of the data, the applications of the data, utility analytics. I really like the IEEE magazine that came out on utility analytics and some of the realm of the art of the possible when we start taking a hard look at some of the information that's out there and what can we use it for.

I think from the synchrophasor stuff, we've learned that there are some really insightful validation tools that can be developed as well as we want to push that even further because there is a lot of value out there that can be achieved. If we can exchange the data, take a hard look at the data, marry the data up with other data such as weather patterns, et cetera, I think there's a lot of value that can be obtained from that.

So we increased our emphasis from the data analytics as well as modeling, to look at advanced tools, advanced applications, and so that is the purpose of that organization is to continue to drive the tools and the applications that were asked of the Department to develop.

Now you'll notice that I did not mention once that we created a cyber security organization, which may be to the surprise of some of you. And I have a fundamental philosophy that cyber security has to be part of every R&D

activity, every piece of developmental work that we do as an industry or as an organization. So, whether I'm talking about a smart grid project at the distribution level or a transmission project, we have to think about the cyber security, the security issues.

So I'm trying, and will continue to try, to push really hard that cyber security and security resiliency be inherent to everything that we do. So that's why it is not pulled out as a separate organization.

So that is a brief summary of the reorganization. Like I said, it's like tweaking of what we're doing but trying to really emphasize some of our strengths and what we should be working on.

As for priorities in the organization, I think a lot of it will continue to grow from some of the discussions that we have here. But, right now, it goes back to continuing to support the reliability, the resiliency of the electric grid, the functionality.

I liked how Anjan posed that it seems we're being pulled in many directions, that the grid has to be it to everything and be all to all the folks out there. So, in order to be all that it can be, it has to support a lot of different policies.

And that's, I think, where the struggle is. We have a lot of interests out there with respect to investment strategies, and we have to ensure that we maintain reliability while looking at the diversification of our generation fleet, the changing mix of the generation fleet and some of the stuff that Anjan talked about.

I like the way, Gordon, you presented that what we are doing is looking at the architecture and how do we balance that architecture in the future. I made note of that -- that that is in some ways how we're trying to take a systems approach and saying, really, where are some of the gaps and where do we need to move forward to get additional value or efficiency out of the system.

In some ways, we have started some pilots, some pretty big pilots. I think with the success of some of those programs, now the question is, how do we implement and execute on a larger scale? And that's where you're starting to get some of the challenges for data sharing and information sharing, data exchanges.

I'd like to -- and especially as we get into the next generation EMS system, Mike, is really take a hard look at how do we define success because I find it interesting that people define success differently. So that's one of the things that we need to go forward of -- what does success look like -- and that is a question that we started asking as we were looking at the synchrophasor program.

We will achieve visibility across the system, but is that good enough? What else can we do with that?

And I think the industry has rightfully said that we can do more with this technology and we should be developing more applications. But I also want to make sure that we do it in a proper timing so that we actually have all the information sharing agreements, all the things in place, that we're successful at the end.

So those are some of the things that I'm looking at. I know there are a lot of other priorities that we'll continue to talk about throughout the day.

But I just really wanted to, number one, extend my thank you for you all being here. It's an important forum for discussions, and I value your input. And so, I just wanted to say thanks.

MR. COWART: Thank you very much, Pat. We know you do, and your support for the Committee has been terrific, and it's been obvious.

MS. HOFFMAN: With that, we're up to a break.

MR. COWART: That's right. I think we're up to a break time, but I want to just give members of the Committee the opportunity to comment or respond.

Gordon.

MR. VAN WELIE: Gordon Van Welie, IS0-New England. Pat, I was just curious about how does the Grid Tech Team fit into that organization structure. Does it cut across it?

MS. HOFFMAN: We primarily support the Grid Tech Team with several members on the Tech Team. The Tech Team is actually across the whole Department of Energy.

So we have the renewable programs that participate, the fossil programs. So I would say that we are probably an implementer-executer of some of the activities of the Grid Tech Team, primarily driving the systems approach.

So, as the other organizations are looking at how do we reduce the cost of, you know, a solar panel our wind, our role is how do we ensure functionality, reliability and support for the electric system.

So we're technology-neutral, but we're going to drive the recommendations from the Grid Tech Team from the systems point of view.

MR. VAN WELIE: I'm still not 100

percent clear on that. Is the Grid Tech Team reporting to you, or is it part of one of those divisions, or is it something that sits outside the matrix?

MS. HOFFMAN: It actually sits outside of DOE.

MR. VAN WELIE: Okay.

MS. HOFFMAN: And because it's a departmental activity, right now it's a team that reports to what we call the Undersecretary of Energy, so the S3's office.

MR. COWART: Okay, we are up to our break. I'm sorry. Others want to comment. I'm sorry I didn't see it.

MR. PETERS: Chris Peters, Intergy. Pat, based on the enormous attention from a cyber perspective with regarding grid security and what you've seen through your analysis from your maturity model, where do you see the future of DOE from a cyber perspective, supporting the industry and working with your other, I guess, peers, with DHS and NERC?

MS. HOFFMAN: So let me address that a little bit. Cyber security will continue to gain importance, and we all need to focus on it. Where we want to drive -- and it's probably very similar to, I would say, the analogy of the synchrophasor activities -- is how can we build more capability within the industry and the information sharing agreements so we can get ahead of the game on what potentially is seen on the system. And I think that's the core of having utilities on our operators, TOs, ISOs -- really look at their situational awareness tools and capabilities.

And we're going to continue to address each of the domains of the maturity model and look at what is the appropriate level of information sharing and development in the industry sector with each of those domains. My highest one focus on right now is situational awareness.

With respect to the interagency and the coordination point of view, what you'll see emerging as the role of the Department of Energy is going to focus on R&D. So, from a white-listing point of view, how can we help secure, look at the next generation system?

I guess the point I'll make here is securing the electric grid does not mean hardening it from adding stuff to it -- more plates of -- you know, from a security point of view. When people talk about security, they say, well, we'll just add another layer of protection on. I think it looks at fundamentally looking at the architecture of the system and how do we modernize while securing.

And so, that's what our role is going to be -- how do we continue to look at it from a cost effective point of view, securing the system?

There's going to be tradeoffs, and so part of the things that we're going to have to help with are the decisions of what are some of those tradeoffs. We talk about the states making -- having to make -- some of those difficult decisions from a prudence and investment point of view. But we know that we have to say, okay, what is the most important, cost effective -- or most important investment from a cyber security point of view and what are some of the tradeoffs?

There may be some risks that we're going to have to accept in the system, but how do we start to dialogue on that?

And so, through the maturity model and through what I believe the role of the Department of Energy is, to help with some of those decisions as we continue to modernize.

Where DHS falls into play is probably from some of the incident management point of view. We do report to DHS when there is an emergency under ESF-12 from a hurricane point of view. I see a very similar structure evolving from a cyber point of view to that type of analogy.

So I hope that helps.

MR. COWART: Anything else?

(Pause)

MR. COWART: All right. We'll be on break until 3:30. Thank you.

(Recess)

MR. COWART: Okay, dear friends, please take your seats, and we will begin.

(Pause)

MR. COWART: Our next topic is a panel on Next Generation Energy Management Systems, and I'll just turn the gavel over to Mike Heyeck.

MR. HEYECK: Thank you. I know you are all excited at this late time in the afternoon to talk about the geek in me and the geek in these folks, about the next generation EMS. This is the energy management system. This is the grid operating system.

Let me draw an analogy to the problem. I'm in central Ohio, which is ground zero for the national political campaigns. We are data rich and information poor.

(Laughter)

MR. HEYECK: Well, Clark Gellings and I were, a couple years ago, visiting Red Eléctrica who is the Spanish grid operator, and the Spanish grid operator said there are three fundamentals, and I never forget it. One is interconnection standards, the second is interconnection, and the third is visualization.

Interconnection standards, because they had a fault in northwest Spain and 2000 megawatts of wind just dropped off like that.

Interconnection, because of the intermittency, or the variability really, of the energy source that they have. They have a lot in the Iberian Peninsula, not just Spain but also Portugal. My wife is Portuguese.

The intermittency and the variability require interconnection. Well, they only have a 1,400-megawatt tie with France, and they're about to build something which might bring that up to 3,000 megawatts, to France. Well, they're the size of ERCOT, somewhere in the neighborhood of 60,000 megawatts.

So, interconnection standards are important. Interconnection, the capacity of interconnection is important.

And then, visualization. And we were in their control center. Not unlike control centers all over the world, they have a great video board and there's a lot of visualization, but it's built on the technologies that were developed many years ago, in the sixties and the seventies.

So I'd like to leave that anecdote there for a moment.

Another anecdote is Recommendation 13. Oddly numbered, Recommendation 13 of the Blackout Report of 2003 stated that the Department of Energy is to grow the phasor measurement units.

Now this is 2003. Dave Nevius and I would recall before the PC was born we were talking about phasor measurement -- synchrophasors. There you go. And they produce a lot more data -- again data rich -- a whole lot more data than the old SCADA systems.

The old SCADA systems' data frequency is measured in seconds, and the data frequency of phasor measurement units are measured in milliseconds.

And on October the 5th, Terry Boston was at that meeting, and he mentioned that in PJM they have a 163,000 control points that they manage. 163,000.

Then, Ralph Masiello said you might as well add three zeroes to that because that's where we're going to be.

Think about the pole-top photovoltaic. Think about the EV. Think about the distribution management systems with the magnitude of data that they're going to provide. The system is going to be inundated with not thousands, but millions, of times what we're seeing today. So how does a grid get managed?

Now I've been a grid operator for a long time, and a transmission owner, but the grid is just fascinating machine. It is balanced every moment of every day to make sure load is balanced with generation. That's the fundamental thing.

But think about the grid of the future. Today the grid is a big mass of stuff. The big masses that are spinning today provide you the shock absorbers that we've been used to. Those big masses are going to be retiring, and smaller masses are going to take their place. But also taking their place is going to be a lot of information, a lot of power electronics and so on.

So are we replacing mass with speed? The shock absorbers of the grid are going to be challenged in the future because of the magnitude of the issues that we're going to deal with.

Now let's step back from that. The grid operators today have some systems out. They're from either Siemens or Alstom or some ABB or other players out there. There are not many players out there providing EMS systems. There are not many customers either.

The grid operators are bigger, and there are not many customers. Therefore, their margins are low.

If their margins are low, how would we advance the technology that's going to be needed to deal with all the equipment we have today, and the data and the frequency of data by which it transmits to the central points?

So what are we going to need? Well,

David Meyer came up before and talked about the conundrum that we're going to be dealing with, and that's funding. How do we fund this?

But first, I wanted to have this panel of experts talk about the issue of the day, and that is: What is -- what are the problems and what's the vision of the grid and the energy management system for the grid?

And then, we can talk about funding afterward. And I encourage you to write some notes down for these experts that we have, and let me introduce each of them. First, we have Robin Podmore. And, first of all, I want to thank Gordon and Ralph Masiello and some of you for providing these names to us. The amount of talent we have here is could be added up and come up to a century of experience.

I'm not talking about your ages. Robin Podmore. From 1974 to 1976, he managed the Power Systems Research Group at Systems Control, now ABB, in Palo Alto, California. And from 1979 to 1990, he was Director and Founder of ESCA

Corporation, now Alstom Grid. Since 1990, he has been Founder and President of IncSys.

He has more than 40 years of managerial and technical experience in the development and implementation of power industry computer applications. For more than 20 years, he has been working on making operator training simulators affordable, available and usable for all power system operators. The IncSys power system -- power simulator product is now used to train more than 50 percent of North American Electric Reliability Corporation's certified power system operators.

Next, we have Petar Ristanovic. He's Vice President of Technology with the California ISO. He joined the ISO in 2010 and has more than 25 years of experience in the electric utility industry. Besides overseeing all technology functions for the ISO, he also leads the Program Management Office.

His career includes developing strategies for technology use, introducing new technologies and power system applications, developing and deploying advanced IT solutions and system architectures, and implementing large-scale, complex utility control centers.

Next, we have Tom O'Brien from PJM. He's the Vice President of Information and Technology Services. He joined PJM in April 2002 and is responsible for all aspects of PJM's information technology services activities, including integration and application services and infrastructure operations. Additionally, he has provided active leadership for implementation of the Advance Control Center Program, including oversight of creation of a new information and application architecture for PJM's energy management and market management systems.

Next, we have Eugene Litvinov. He's from the ISO- New England. He's Chief Technologist there. He's responsible for advanced system and market solutions, smart grid and technology strategy, and is a lead of the research and development activities in the organization.

He has over 35 years of professional experience in the area of power system modeling, analysis and operations, electricity markets design, implementation and operation and information technology. He has extensive management and technical leadership in large engineering and information technology projects.

And I'm going to start with Robin, and then we'll continue with the next three after he's completed. What we're going to do is have them do opening remarks, and then we'll have a Q&A session afterwards.

Robin.

MR. PODMORE: Yeah, thank you very much, Mike. And, clearly, it's a great honor to be here, and I appreciate the chance to share my thoughts.

So what I put together was a few slides that cover the main questions, but one of the things I wanted to point out is that even with the smart grid and smart grid controllers it's not a matter of when the control systems will break --

I'm sorry. It's not a matter of if they will break; it's a matter of when. Okay.

Even the best technology at some point is going to have some issues. And so, at that point we're going to have to have even very smart grid controllers in place, aren't we? The generation of operators that we train has to be excelling at dealing with these complex systems.

You can probably tell from my accent I grew up in a place way south of here called New Zealand and came to the U.S. in '74. And I never dreamt I would be at an audience like this, and I never dreamt that my son would join the Naval Academy and go to the Marine Corps. So I am an extremely patriotic American, and I love this country down to my boots.

And the military are amazing, the way they train, and I have drawn a lot of parallels. The Marine Corps training and the Navy training are the best in the world. And so, there is a way to go forward, to really -- we have some of the best minds in the industry and the best men and women in this country, and we've got some very interesting challenges.

So one of the initial question is, how are we going to handle all this variable generation, and not just the distributed, but the centralized?

Basically, my proposal is let's do it in two steps. Let's not try to get to 1,000 times the number of points. A thousand times the number of points basically takes you down to every customer transformer, every -- and even into the appliances in the home.

Let's just start out and go to the feeder breaker. All right?

If we're going to model where all these PV solar and local wind turbines are, we need know at least what feeder breaker they're on. Right now, most feeder distribution systems run radially. So, if we aggregate at that level, then we know exactly where those devices are.

I think the idea of DOE as a convener and a stimulator is an excellent one. Secretary

Chu had us all thinking very deeply when he mentioned that it's only a matter of time before you can go to Wal-Mart and buy 5 kilowatts of solar with built-in storage for $2,000.

Everyone around the table, DOE has an ability to see all the different pieces and connect all the dots.

Everyone at the table, I think the fact that virtually you have that ability to call the experts together, from the executive to the research level, and get us all thinking deeply.

How do we think deeply? Well, we can do a certain amount of meetings like this, but it's hard. The best way to think deeply is to build a simulation. Okay, an accurate simulation.

So the proposal is let's build a model, a master model of each interconnection, and let's take it down to the feeder breaker.

Our top-down estimate -- we figure we're getting close to 1,000 gigawatts a load at an average of 2 megawatts per feeder, and we would have 500,000 feeder breakers. That's not a very big model when you look at Google Earth and Google Maps do, is it?

And we have some real-time data we have to get through, but in terms of building that model there are no technical problems. There are clearly institutional issues: Who's going to own it, who's going to have access to it, and who will be the lead?

The nice thing I think about the meeting Anjan talked about is that the industry clearly stepped up and said: Let's get a group that represents reliability authorities and is not involved with compliance, and let's put that group together, and let's build one of those for the Eastern Interconnection. We already have models for the West. We have models for Texas, but we do need to go down to the feeder breaker.

The breaker feeder level is essential for restoration. You cannot do restoration at the high level once high level. You've got to do it feeder at a time, and so that's really important.

So, in terms of situational awareness --

I guess I could turn this on. Clearly, everyone can hear me a little better now. But -- all right.

Okay. There was another question. What's the impact of PMUs?

PMUs can clearly give us a look at the oscillations that are occurring in the system, but the nice thing about PMUs is they can give us the ability to accurately estimate the system topology at the SCADA scan rates. The operator is not going to be making decisions based upon data bearing at 60 times a second. He's going to sit back and take a few minutes to assess the situation.

But right now, the energy management systems are what I call fair weather applications. They run really nicely when the weather is fair, when you have all the data and the system is not highly stressed.

We need applications that can run in the really bad weather, when there's a storm coming through. You've lost half your communications.

You've lost half your transmission equipment. That means those applications have to be much more robust.

The PMU data gives you -- tremendously increases your redundancy to be able to determine when something is out of service, when it's not really service, and it can make those applications really robust.

A good example is in the airline industry we have wind shear warning systems. There's a heads-up display if the pilot is coming close to a wind shear. Massive calculations are happening and giving that pilot the warning. We need to have both that you're getting to the verge of voltage collapse, the verge of stability collapse.

We need to have a massive education program. Most people in the airline industry know why airplanes fall out of the sky -- when they go too low or their angle attack is too high.

Only a small fraction of people in the utility business understand that the power system has certain limitations. If you push the power across a transmission line, it's like a series of rubber bands, that a disturbance -- yeah, we had Senate hearings where people were saying, how could something that started in Cleveland cause a 60 million person blackout? It's because the power system is inherently unstable, and we have to keep it running within close limits.

In terms of where -- so that's the idea of having little pie charts that show how stressed these various transmission lines are.

Looking down the road, we've heard the comment that these distributor renewable devices should help the system and not hurt the system and having load control can help. Basically, 60 percent of the load in Los Angeles can be turned off for about 5 minutes, and you wouldn't have too big a complaint due to the thermal inertia. Think about that.

All those single-phase air conditioners can be turned off for five minutes. In that five minutes, you can be starting up your aeroderivative turbines. They can be up from zero to full load in five minutes. You get those turbines started up, and then you've got time to figure out how to redispatch the system to make it economic again.

So I'm encouraging people to once you model down to the feeder breaker level you can be seriously looking at how to do direct load control and how to do this balancing.

So we have to deal with the system being much more variable and, fortunately, due to the price of gas being much lower than we thought, we're going to have a much more responsive generation source to deal with the fact that a lot of the renewables cannot be directly controlled.

What's the road map for DOE? Continue to convene meetings of industry leaders. Continue to work on EMS R&D.

Many of our universities now are dealing with a model called the IEEE 118 Bus, which actually came, I think, from Mike's power system when they owned -- the maximum voltage was 132 kV.

We need to have a set of tools that researchers can use that are much more open. We're proposing they should be hypothetical systems. We cannot be giving -- our universities are fantastic. They attract people from all over the world but even from countries that don't like us that much. So we need to be providing researchers with hypothetical systems that are outside of critical energy infrastructure information.

Let's see. The idea of open-source applications -- we've seen that take off with things like Linux and Apache. I guess the question is, where's the next Linus Torvalds of this business going to come from? Okay.

We need to find -- I think we're at an exciting point. We can be attracting the best minds in the U.S., and those DOE laboratories can be a tremendous proof of concept center.

This is the existing Electric Infrastructure Operations Center at Pacific Northwest Laboratories. That is nicer than a lot of real control rooms, all right, in terms of the projections and the consoles. And so, one of the things that Pacific Northwest Labs has been doing is bringing in real power system operators to work with real, very detailed simulations of the grid and train those operators there. So you get a great combination of real operators working with high powered researchers.

Let's see. The question came up too -- what's the role of standards and NERC?

Should we do standardization, or should we do research first?

And we've had the whole question of data versus models.

I believe the -- if we -- one thing that came out of the 2003 blackout was the requirement that every operator have 32 hours of training. We had tools, trees and training as the three causes for blackouts. As a result of that, the industry all got around the idea of let's provide low cost simulation- based training for system operators. And if you do set a standard, then that encourages the entire industry to get behind that standard and drive down the cost.

So that -- I think the going rate right now for the high fidelity simulator-based training is about $20 per operator per hour. That's a lot less than you pay for baseball lessons. Okay.

So don't worry about the standards. You can put the -- my point is put the standards in place, and then the industry will innovate and clearly drive down the cost.

And this shows some of the unique things of people who have to be system operators -- high stakes, high task loading, lots of uncertainty, dynamic settings, multiple players, time stress, organizational factors.

And, guess what? Many people who have been in the -- if you've been in the military, you've lived in those environments.

So I'd like to just make one -- we were fortunate to get a DOE ARRA smart grid funding award, and through that we have been recruiting, training, certifying veterans for power industry jobs. We've placed about 80 veterans, and we've taken them from no jobs, no interviews, to operating the grid with very, very good reviews from their supervisors. So that's been a great -- yeah, a great reward.

So, with that, I think -- yeah, I've covered the highlights, and I'm happy to hand it over to the panel.

Thank you.

MR. RISTANOVIC: Good afternoon. Thank you for the opportunity to talk today about this important subject.

We pretty much have a common understanding of what the problem is. The rapid growth of renewable resources and distributed generation and all these new electronic devices is, at the same time, a great opportunity but a new research challenge for us. So it's not that we always see this as a big problem. We see also some opportunities.

This change will drastically change day-to-day operation of the system and not just how we see it. We have to also understand that it requires a change of some reliability standards that we've been living with for so many years.

The traditional structure of the utility business where we had clear distinctions in generation, transmission and distribution may not be appropriate for what's coming. If we just think about that generation will show up at the retail level and that we have to pull some information from it to the wholesale level, it's almost impossible to draw boundaries like we used to and organize business around that.

These changes will come. Many states have very aggressive goals to reach the renewable standard. In California, we have a goal to reach 33 percent renewables by year 2020, without counting hybrids. So it's going to happen, and we have to get ready for that.

There are four main implications on what we have to solve every day. Because of these renewable resources distributed and concentrated, we have a new variability in the system, which is variability of supply in fuel supply which is directly correlated to other factors.

Deployment of a large number of ideas will present another challenge, which is a big number of measurements, all this on a magnitude higher than what we used to have. We were always complaining that we didn't have enough information to estimate the system. Now we have more than we want. So we have to find a way to deal with that without using excuses about size.

These devices, as Mike said, will change the inertia of the system. Instead of a small number of big pieces that have big inertia, you have a large number of smaller pieces that have no inertia. So, obviously, the dynamic problems in the system become much more complex and have to be dealt with in a very different way compared to what we historically did.

The fourth biggest change which became the biggest impact is that all this information coming from the houses and retail level all the way up to the DMS EMS systems will require use of all kinds of communication channels which will magnify the goal of securing those channels because a lot of information going up and down will be very proprietary, private, confidential information that has to be protected. We never had anything like that before. We had always had dedicated security channels between our control centers and whatever we were controlling or monitoring in the field.

These new challenges, or new opportunities, or combination of challenges and opportunities, requires changes in at least three areas: We have to look for new EMS architecture. We have to think about situational awareness in a way that's never been thought about before. And we need new, improved EMS software tools.

Today's EMS platforms are not designed for high data volume capability and flexibility that new transformers will require. Although major EMS vendor systems were following a well defined technology upgrade in the last 20 or 30 years, they never fundamentally changed their underlying architecture because they didn't have to. Now this new requirement will require fundamental change of that EMS architecture.

If we construct a new EMS system on well defined function and components, we may achieve that required flexibility level. In order to separate those flexible components from the platform, we really have to define some new what we call EMS platform services and build them in a way that they become commodity. So vendors can focus on high level services and functional components and not on technology or vendor architecture update.

And there are platforms like that. I mean, we just need to look into e-commerce. E-commerce is solving problems like this, meaning size and volume of information that has to be processed. So we just need to learn and deploy those best e-commerce practices in our space, and we will have probably a very good platform.

What is different between our system and these e- commerce systems is that if you are down it's not just that a customer cannot buy a book or their Visa is not working because they can delay that and do it a little bit later. If we are down, we can have big implications on the supply of energy.

And I am assuming that even with all these new changes we will still follow the model of electricity all the time, not electricity when you need it. So we have to be operating at a high 59s or 49s availability number.

So this system has to be designed to be resilient. And resilient doesn't always mean hardened. If you look into the outage of 2003 and the latest outage we had in California on September 8th of last year, those are two circumstances where those uninvolved which they were not interconnected because we build these interconnections to deal with frequency problems.

If something is an outage, something else will pick up the distribution and stay alive. But if you have an outage that causes a cascade of thermal overload of the transmission system, that propagates very fast in a wide area and you have a larger blackout. So we have to have systems that will survive events like that, not just frequency deviation.

The new EMS platform that we are looking for needs to be based on standards -- industry standards based on models and interfaces.

When I say it's not a model interface, a standard data model is something that you know is enough to represent all the elements of the system you're trying to monitor. But you also need to define standard functional components that we know change in the future and between those standard functional components, so we can enable competition among the providers of the system.

As Robin said, even with the most advanced EMS system, the most advanced architecture, the smartest grid, there are situations that the system will go down. There are situations that software cannot handle. There are situations that may not be avoidable, and software can't handle them.

So we have to accept the fact that we are expecting the plane that you are flying may go down. We just need to build systems that will minimize these events. And what is equally important, or more important, is when we go down we need systems that will provide tools to minimize how long we are down because if you have an outage of, let's say, 5,000 megawatts in a load and it lasts 1 hour, it's not as bad as having 3,000 megawatts for 10 hours because implications are much larger if the time that we are down is longer.

So we don't have good tools today, and we will need tools like that today because this smart grid will introduce some kind of intermittency and instability in the system that will increase the likelihood of going down.

Now, situational awareness. Too frequently we think about situational awareness as these nice graphical charts where we can see these counterdiagrams and present a very large amount of information in a nice graphical way so people can get the idea of what's happening in the system. That's a big step. That's a very important step, but that's just scratching the surface of situational awareness.

So we say the operator, instead of scrolling through thousands of pages of data, this place now has a big map, has colors and he can quickly narrow down where to look. But that's just looking at where we are.

And I saw the example of driving a car, and you know, that's how my wife was driving a car. She was always in front of the car, and then we made a big improvement that she looks like 100 yards ahead of the car because that 100 yards will come.

So we need something like that. We need something like that in our EMS system where you know where you are coming from, what is the recent past, because there may be some trend built in that recent past. You need to know where you are, but it's most important to know where you may go and, depending on those critical scenarios, what you may do.

Let me tell you it's a situation like that. When you have a problem in the system, the operator has three ways to deal with that.

One most efficient way is to anticipate. That's what we like to say -- keeping the system in the N-1 secure state. So keep the system away from where you can be in trouble. That's the most efficient counteraction the operator may have.

If you are unfortunate and that help doesn't help you and get in trouble, the next most efficient action in the system is that the automatic protection works properly. It is designed properly and works as designed, but is properly designed, because we had on September 8th that some protection worked as designed but not as we would like it to work.

And the last on the list is corrective action by the operator. If you run into that third board, you are having a big problem to solve and you may not be able to keep the system going.

So how do we achieve this high level of

situational awareness? All these graphical tools are an important big step, but we have to have better integration between real-time operation tools, planning tools and short-term operational planning tools in the way that will give the operator this true situational awareness, where you know where you're coming from, you know where you are, you know where your system may be going, what's the difference, and if you run into some of those critical trends, what you need to do.

Many things that we do in the system, and especially for situational awareness, are directly leading to forecasting because in order to anticipate where you are going you have to forecast the system ahead. And there are a few things you need to forecast. What we used to have in traditional forecasting is just one of many things we need to forecast.

Because of some of these devices, like you take rooftop solar devices, you don't have visibility because nobody is going to put AMI on the rooftop solar, even with all this proliferation of the smart grid. So it's not reasonable to you, but it's part of the load. So that's going to make the problem of forecasting very difficult to solve.

In addition to that, our traditional way of forecasting reserves is not going to work anymore because we said before I have largest generation, largest load. The biggest of these three is my reserve. It's not going to work like that.

You may have like this Red Eléctrica case. You may have a drop in the renewable production that is a couple of times larger than the largest generator you have in the system, the largest inter (inaudible). And it does not happen suddenly. It happens in 15 minutes. But the impact on the system is the same. In 10 to 15 minutes, you may have to have 5 or 6 thousand megawatts of ramping to recover from that.

So low forecasting and forecasting in general have to improve significantly for us to handle this transformed grid.

Something about how we get there -- the EMS business on the surface is not competitive. In the last 20 years -- I was on the dark side for more than 20 years -- it went down a couple of times. So what used to be a system of, let's say, 15 or 20 million dollars, today is 3 to 5 million dollars. So, in 20 years you have a 3 or 4 times reduction in the price of the system because of competition, whatever. Salaries for people building the system didn't go down. So these companies really have limited possibilities to introduce true innovation.

And there are limited players. There are three or four global companies. And they have platforms that are very difficult for third party providers of software to provide the elements that you can come into those platforms.

And then, customers are very reluctant to change their provider because it's very expensive to bring the system up once. And they're not designed for seamless migration to other vendor systems. They introduce a lot of customization into the system. So it's a very unusual situation that a customer changes its EMS provider.

So there is no incentive, or a big incentive, for vendors to introduce true innovation. So they are following technology changes like new versions of databases and things like that, but they're not fundamentally changing the system nor adding new functionality.

So the big -- I firmly believe the best way to introduce innovation is competition, but the big question is how to open that whole business for competition.

And I believe the way to do that is to build a standard platform based on standards with standards industry services, what we used to call plug-and-play, to define very clearly function (inaudible) Seagray effort, and have vendors, small and big, compete so we as customers can change this part of -- where we change our grid. I call it upgrade the system every like 8 to 10 years to something where we can incrementally improve our system every year, but every 2 or 3 years, without being forced to always go with the same vendor. We can get the best that is available on the market.

I think that's something that, you know, if you help us get there. And I have spent probably a good 18 years trying to achieve this through many different organizational standards.

At the end, I think the biggest move is when my company -- I worked for Siemens -- got the project with PJM. We built AC2. That was a big step. And I'm trying to do something similar in California ISO, following the same idea about standard platform, standard services, standard functional components, and I am firmly confirmed that's the way to go.

MR. O'BRIEN: Okay. I'd like to thank the EAC as well for the opportunity to talk a little bit.

And it was interesting listening to the conversations earlier in the morning and also listening to the panelists. There's a lot of commonality in terms of themes and things that we need to work through.

And there's something that Petar said, that I thought I would lighten up the moment -- is there was a -- he referenced plug-and-play.

And years ago, I was at a conference, and Scott McNealy, who was the CEO for Sun, had a long battle with Bill Gates over Microsoft. Microsoft was always plug-and-play.

And Scott came in front of an audience. He said, we're going to do something different here at Sun. We're going to do plug-and-work rather than plug-and-play.

So I would like to kind of add that to it. I think really the theme behind some of the things that we're talking about is really how do you make all this work within the context of everything that is changing.

What I'm going to cover here is a little bit about the evolution that we're all faced with right now, and I won't go into it too much because we've really covered quite a bit of it. But I do want to spend some time talking about extending the integration architecture because that is one of the key things where I think additional research, and I'll also talk a little bit about standards as well in that.

I want to talk about this notion of big data. I'll be honest with you; I hate the term. Big data is a term that just confuses everybody. But there are lots and lots of data out there, mammoth amounts of data that we need to manage and we need to work to, and I think R&D is a big piece of helping us get there.

And then, finally, I'll talk a little bit about PMUs, and then I'd like to pull it all together with what I see as some of the key areas in the road map.

I won't spend much time here, but in the end the evolution of the EMS has to support the key business trends, and this slide is right out of the PJM corporate strategy that we had developed and is posted on our website. But I think it fits very well with what everybody covered here, and I'm going to start at the left.

The whole transition to gas is huge. It's, you know, the whole shale gale. If Terry Boston were here, he would say this is maybe our first chance at energy independence in the U.S. depending on where it goes.

But there's a lot of opportunity with shale gas. It's not everything. I think we would be the first to say that you want a portfolio of investments, but with the forward price of gas and the amount of supply, it has huge, huge impacts.

Additionally, that's leading to the integration of new infrastructure. I will not go into all of that because we've talked about renewables, wind, micro grids and all of that. But all of that has an impact to our control systems and impact to our EMS systems and, ultimately, an impact to our integration architecture, which I'll talk about.

The one thing that we didn't talk a whole lot about, but I think is also part of the play, is this notion of responsive load. Most of us that grew up in the industry -- it was always generation chasing load. Now we're getting into a world where load is starting to follow gen and looking at it very differently.

And I think Petar referenced the notion of load forecasting. Well, that adds a whole new mix to how you do load forecasting. It gets into behavior rather than just neural nets, with weather being the key thing, but a lot to do there.

The one thing I do want to really highlight on this slide because we haven't talked about it a lot is this notion of managing cyber security. And I can tell you from my perspective this is real. This is something really serious and something we all need to focus on, and we need to continue investment on.

It would take too long to get into everything that we need to do here. But at the end of the day there were some comments that, yes, we've got to stop the bad guys from getting in, and that's the traditional prevention controls.

And, yes, we must stop the bad guys from getting in.

Secondly, what do we do when the bad guys do get in? It's the whole resiliency play. A lot of it is playing out right now in the media relative to outside of our industry. And what are we going to do when it happens in our area?

And, finally, in cyber security, I think one of the greatest opportunities is the collaboration we can have across industries, with the government, with education. There's a lot of opportunity there.

I promise I won't talk about all of this. Okay. But I wanted to use this slide kind of as a springboard for the integration architecture.

You know, we all grew up with these monolithic EMS applications that really just talked inside their own box. At that point in time, it was fine. It worked fine. But we've really come into a world right now where, with all the changes that we're facing, one big monolithic system doesn't work.

And a couple points that I want to talk about here is the first one -- again, it's a reference to what Petar had mentioned as well, but the information model manager. Okay.

I think one area of investment is really around model management, and it is bringing together the operations models, the planning models and the market models. And they're all different, and they're all different for good reasons, and they will probably always be different. But from a standpoint of a common source model that you can use to power future applications is really important because some of the things that prevent us from driving innovation is every application needs a model.

And how do you make sure that that model is right? How do you make sure that it's up to date? I won't get into all of that, but that, I think, is an area for investment and making sure that our models can get us where we need to be.

There's an application up here --

intelligent event processing, which was part of our advanced control center program where we had put that application in place. It's the tip of the iceberg. It's not the end-all, but it's something where we're looking at how do you look at events that are running across all of these platforms, not just the EMS but the markets running across other ISOs.

How can you look at those events and manage? And that intelligent event processor needs a model as well. So, which model is it going to use? But I think that is an example of some of the analytics that we really need to be focusing on. We reference this notion of shared architecture components. In short, we really want to drive the vendors not to be investing all their dollars in plumbing. We'd rather have them investing their dollars in new applications and innovation. The problem we have today is they're all investing money in the plumbing. And, if we can develop common services that can be used across applications, you're not reinventing it all the time.

The last thing that I'll say on this slide -- and it's at the bottom right -- is this notion of information storage. And I've got another slide that's going to actually touch on that.

But it's huge -- and I'll actually go to that slide right now -- and it's kind of the notion of breaking down all the silos.

There was the reference that Terry Boston had made about the 160,000 control points in our current system. Tens of millions of control points at the home in the distribution level -- and we're not even talking about PMUs yet. Okay.

PMUs are enormous amounts of subsecond data, and figuring out how do you store it and how do you manage and how do you write applications with that.

I think when we look at the network model across all of this there are two things that are clear. The model is going to get broader, and the model is going to deeper. And we need to be looking at technology and working with not just our systems engineers but with the technologists from companies that are not typically the big three or big four in the EMS world.

But there's a lot going on around technology with massive memory management. How do we pull some of that into the work that we're doing?

The one thing that we talked a lot about was this notion of synchrophasors. And this slide is not a pure slide from an exact timeline perspective, but it's really looking at PMUs.

And I think Robin made the comment -- I think it was you, Robin -- that PMUs have been around for 25 years and there's nothing new about PMUs. Okay. We just didn't have the opportunity to pull it all together.

And I think with the DOE stimulus funding it allowed us to actually get the PMUs in service and start collecting data. Now what we really need to spend a lot of time on is how do we utilize that information. That's another area of, I believe, research.

And I don't believe it's just what applications do we need to write. I think there are new applications that nobody even thought about yet relative to PMUs. And until we get the smart power systems engineers, the smart technologists and the smart people in the operations room and some academia to really come together and look at those correlations, look at those events and figure out what do I do with it in the control room because the value of the PMUs is going to be how can I prevent an outage, not how do I analyze what happened. So I think that's a huge opportunity for us.

I'm going to close with a couple of things, and it's really the EMS of the future, keeping the power in balance and actually -- I kind of actually plagiarized the slide we had at PJM, and I kind of changed it around.

But at the end of the day, if you look at the left and we look at the -- supply is evolving. It's not PJM's job; it's not anybody's job necessarily, to pick the winners of who's going to win demand response, who's going to win solar, who's going to win gas. But it is our job to figure out how do we keep that power in balance and what is this architecture that we're going to put in place that's going to help us keep that in balance.

I'd like to leave you with the things for investment from my perspective:

Again, strong integration platform that can be supported and maintained.

Strong collaboration with industry experts. It's not -- there isn't one company or one entity that has all of the answers. A lot of the value is going to come in strong collaboration.

I do believe that the EMS industry is way underserved when it comes to this data analytics. I think there's a whole lot going on, well beyond the energy industry, around data analytics that we can learn from. And I think

PMUs will be the thing that actually throws us into that world.

The thing I didn't reference, but my colleagues here did, was the notion of situational awareness. I think situational awareness is something that it isn't one thing. It isn't just sharing displays between ISOs. That's one thing. That's one piece.

It's really how do you look at the situation and how do you look at it in different time frames. It's the situation that's happening in the moment. It's the situation that you expect 10 or 15 minutes from now. And it's the situation that you expect in the next day.

I think that really comes down to how do we share data, how do we have data models that are somewhat consistent that they can be shared across regions -- and they can respect regional differences -- and we can still get to a level of standards that allows us to do that.

Finally, with standards -- and I've made this case a few other places and a few other times. And I may be an island here, but I'll make it anyway.

I don't believe there's a single answer that says, hey, pull everybody in a room and let's develop standards. I also don't think there's an answer that says, hey, everybody go off and do your own thing.

I think the reality of it is that success is going to come in iterations between standards and implementations. Standards and implementations, and we need to QA our standards by the implementations. And if we don't have standards that we can actually implement and are being implemented and are improving us, then we're not getting to where we need to be.

Last thing I'll close with is cyber security. We need to continue investment for the next few years in cyber security. I think the industry has to catch up, and it's going to be a chase.

And I'll just leave you with, again, prevention, resiliency and make sure that we're collaborating.

Thank you.

MR. LITVINOV: Where is it? Oh, I don't see my presentation.

SPEAKER: Is yours in Adobe?

MR. LITVINOV: It's Adobe, yes. Oh, I'm looking at -- sorry. I was trying to find a PPT that I don't have. Good afternoon. I'd like to join my colleagues with a thank you for being ready to listen to technical people. And being the last panelists gives me the benefit of not repeating what others said and maybe being able to express my thoughts that I otherwise may not have time to express.

So the question that I'd like to ask is, why all of a sudden are we talking about the new generation of EMS?

Being a vendor of two first generations of EMS and now on the utility, spending about 20 years on the utility side, what I'm trying to capture is what causes us to actually think that we need a new generation of EMS and what it is.

And then, I'm going to talk about several directions that EMS can take, and then, as I was asked, my last slide would be how I can see the road map to building a new generation of EMS.

So I think there are two major things that cause us to think about the new generation.

One is we have a breakthrough in computational capabilities, and a technology that we have today and a thing that we could not do in the first maybe 20 or 40 years ago are now very easy to do. So there's a lot of people in the industry now that could easily create new computational engines that used to be prerogative only for the big EMS vendors.

It is much easier now, instead of starting everything from scratch, reducing some very common libraries, mathematical libraries, to build really efficient software. But the problem is that it's not easy to get it into EMS. And I'll talk a little bit about this.

And the second one, as we all discussed today, is our business is changing. The system that we operate today, in 10, 15 years may look completely differently.

And one thing we don't necessarily know is how that's going to look because we haven't made up our mind as an industry what the architecture of the official system is going to look like. Is it a bunch of micro grids, a fully decentralized system, or is it a very rigid, large, interconnected, meshed backbone that we operate, or something in the middle? And that's something that we have to decide.

How much is centralized versus decentralized control we can now allow for our system?

We've been operating the system in a mode that we are trying to prevent everything. We want to prevent blackout, but we have to learn that it's impossible to prevent blackouts. They're going to happen. So what we have to learn is how to react quickly to these blackouts and make sure that we can quick recover this.

I was very pleased to see that more and

more people talk, in addition to reliability, about the durability and resilience of the system which I define as early detection and very fast recovery versus trying to prevent everything up front. And that's a very big change in the paradigm of system control that we have today in the system.

We also deal with different concepts of contingency. Today, or before today, we always dealt with binary contingency -- something either in or out. Now we're talking about probability distribution of different things that could happen. The wind could come up with 70 percent probability, with 20 percent probability, or 90. So we have a whole distribution of things that could happen versus binary line, in generation and out.

And it's a very different reaction of the system when you have to ramp -- if you have a wind ramping 3,000 megawatts within 20 minutes, it's a very different way of following that rather than just reacting on something that was just dropping out of service.

And everybody talked about wide area situational awareness. I'm going to talk a little bit about this. I also believe that dealing with such uncertainty in the system as we're going to have to face in the future, we need a decision support system as a core subsystem of a future EMS that we don't have today, and definitely new applications.

So, in order to make up time, I'm going to try to be a little bit faster.

So I talked about the system, that it's easy now to develop computational components, but it's very difficult to put them in. The problem is our today's EMS is not integration-friendly. It's maybe getting cheaper and cheaper every year to buy EMS, but it's very difficult to integrate it into your system.

If it used to be a very isolated system only operating your power system, now it's a system that is part of your enterprise architecture. It's connected to the markets. It is connected to your back office systems, and so on and so forth. And it's impossible to implement an EMS now in isolation. So not being integration-friendly and platform- independent, it makes it very difficult.

It's also very difficult for the small vendors of the software, or even sometimes superior software, to compete with large, big -- the three big vendors.

We're still using proprietary databases in some of the vendors. We are not making use of decentralized or distributed processing yet. With so much proliferation of IEG substations -- intelligent electronic devices -- there is an opportunity for us to use a lot more distributed processing and saving time in transferring data and processing data.

People mentioned common components that we have to do.

Another thing I'd like to mention is we have, again, a proprietary layer of presentation. So the operators are used to always seeing things through the interface in EMS, and EMS gives very, very limited presentation capabilities. So, instead, we should pull out all the presentation from the EMS proprietary environment into the layer that allows us to architecturally build and make use of all kind of different capabilities that information technology offers today.

People talked about standards, high performance computing, and cloud computing comes up. In fact, we did experiment with some of the highly computational set of tests, and we ran N-1-1 continuously for almost 5 -- less than $5 per hour. So we have to figure out, with vendors, new licensing models for things working in the cloud.

So, at the end, the architecture should be created in order to enable open competition.

The situational awareness has to do with ability not only to anticipate what things could happen but to have a wider view of the system because now a lot more could affect the operation of a specific region.

And, as part of it, we have to create intelligent alarm systems based on contemporary data mining techniques.

We need to create a complex event processing system that would collect. And we do have that. It's not something that we're dreaming of -- a repository of all the events in one place. Then, it can build on top of this system that would be able to process complex events.

We need automatic vulnerability assessment and detection of the events in order to be able to react on something that happens much faster than we can follow.

We talked about a lot of distributed resources across the system. My co-panelists were talking about us losing the line between distribution and transmission. So really now, if we used to be always aware of the perimeter of our system that we operate on the transmission side, that perimeter is blurring. And what happens is we need to know what's happening. We can't ignore anymore what's happening on the distribution side.

So EMS and DMS integration is crucial because DMS would deliver to us that information that we don't really observe. And also, we can coordinate different applications between EMS and DMS on the distribution and transmission side.

We also need to create standards for visualization in terms of really the look and feel of the system. So, instead of very complicated data model exchange, which is sometimes needed for calculation, it's much easier sometimes to just exchange the views, the images.

But if my image is exactly the same conventions and colors and view as my neighbor's, by just giving the image of what they see will make it much easier to be aware of what is going on in my neighboring system. So it's image exchange versus data exchange.

We're also not so far away from creating a national allocation registration where we register all major allocations we can observe. And then based on this, it is actually possible technologically to build an interregional cloud or a base SCADA. So, instead of creating a network of exchanging data, we can pull this data from some national or interregional depository.

I'm letting myself think. If you don't think out of traditional ways, we will never build something new. Whether that's the new generation, we need to be able to fantasize on that. But, in fact, what people do today in other technologies and industries is amazing, and we have to use it.

Clark Gellings has been talking about this for 10 years, that it's a shame that our NG investment in our industries is like second to the last after pet food. It's really very difficult to work in this environment.

Also, observation of the neighboring infrastructure -- weather, gas, telecommunication and IT. Today, for example, if it's we're only considering electrical contingency, tomorrow I can't ignore, for example, loss of some information technology component because it would have the same effect on power systems. It used to be just power system or a large transmission loss because of the proliferation of information technology.

And also, we need compliance in today's business. Decision support system -- we talked a little bit about forecast. It's very important to bring a new set of tools that make use of new approaches to optimization, stochastic and robust optimization methods. Instead of using all this preventive, we need to get to understand how we actually put a risk-based optimal power flow rather than a preventive one.

We need to understand how to analyze and try to predict cascading failure, and there is some research and development going in this area.

How to calculate corrective actions -- we also require now to provide more timely the calculation of online stability limits because they are feeding into our markets.

Important again, adaptive external network modeling and management because we can't really use the same model all the time, if you want to talk about online stability calculation.

And online system restoration with the help of PMU is a task that we have to look into.

So what I -- the way I see the road map -- and again, I'm not absolutely clear what kind of road you could take, so whether it should interfere in the technical or R&D side or much wider, on the policy side. But being a technical person, I'm kind of looking at this as the more technical side.

So, first of all, I think if we do want to invest some money into moving to next generation EMS and being talking about being noncompetitive and having only environment, only three vendors by themselves would never do that. They don't really have enough incentive for the major R&D in this area.

It's good to establish a small team of experts that would develop high level functional specifications and requirements for a new EMS: What do we mean by a new EMS, how do we see the future system, what the major functions and components are, whether we have new performance and capacity requirements and then define standard interfaces.

Then we need to probably review it by a wider industrial group and try to map that vision into a contemporary IT architecture.

Once we do that, I think it would be a great idea to get out-of-industry IT experts to look at it and say, hey, we're been doing it for years. You guys are so behind us. I've heard that before. And so, understand that where we stand as an industry among other contemporary IT achievements that we have.

Then develop a transition plan from where we are to where we need to be, determine R&D needs and fund them if possible, and then stimulate the new application development. It's a big number of very capable labs that were kind of staying away somewhat from the industry and now getting back. I'm in contact with almost every laboratory today that is trying to get into power industry R&D.

And then, run some pilots and see what

happens. And, thank you. Did I make in time? Great.

MR. HEYECK: I want to thank the panelists here. Just a notation, if we were the air traffic control industry and three years from now the planes would number by a thousand-fold, what would we do with the air traffic control system? This is the gap that was presented today.

And I'm going to entertain some questions at this time.

Rich, would you like to take the gavel on this?

MR. COWART: All right, that's fine. You didn't have some leading questions for the panelists?

MR. HEYECK: I think the panelists were very efficient in answering them.

MR. COWART: Okay.

MR. HEYECK: There is one question I will have, but I wanted to get into dialogue with the audience first.

MR. COWART: Okay, that's great. Let's

start with Pat Hoffman.

MS. HOFFMAN: You can --

MR. COWART: You win.

MS. HOFFMAN: I am privileged. Thank you. First of all, excellent set of presentations. I appreciate all the thoughts and comments that were presented. One of the key things is how do we get to where we want to be. I mean, some of you talked about open-source applications and one of the challenges getting the industry and community around asking for and being able to have platforms that are interoperable but also open-source based. And I think that's a challenge.

And I was curious on the first question on how you would get there.

The second thing is I noticed we talked about researchers and -- I'm sorry. I think it was Petar that brought up -- I might be wrong on that. One of the speakers brought up that we should have a different system for researchers to look at, a hypothetical system.

And I guess I've been challenged because I think there's been a lot of great projects that researchers have done in collaboration with utilities and using I won't say real-time data but at least a segment of data on the system, whether it's historical data or otherwise, to really help us analyze what's happening. And I found that those projects have been extremely valuable in allowing researchers to work with utilities.

So my comment is that research must be done differently, I think, in partnership.

The third thing that I guess I would -- it goes back to a line towards what do people think about cloud technology and use in the utility atmosphere and maybe becomes a utility cloud. I like some of the thoughts there.

A question for Eugene is you said risk-based OPF. How do you define risk? Is that more contingency-based or otherwise, from your slide there?

And then, the last comment that I guess from a state's point of view. I think also the states can help with driving the coordination and interoperability of platforms.

I bring this up, but I'm not sure whether I should or not. But I know one of the smart grid demonstration projects actually has all the utilities within a state, and I believe it's in the Southeast, with a coordinated outage management system. And I forget -- I'll look into that further, but there is something that we could probably get even more value out of it as we coordinate some of the platforms.

MR. HEYECK: Just make sure you use the microphone. And we've got a lot of questions out there, so if you keep your answers brief.

MR. RISTANOVIC: How do you turn this technology on?

MR. HEYECK: Yes, it's on.

MR. RISTANOVIC: It's on? Something about open source -- we don't consider a need for open source. We have to give capability to vendors to do proprietary pieces of the platform that have standard interfaces to support the interoperability. So, if somebody wants to do it on Oracle, as long as this piece is talking the way we define, it's okay.

So we want to leave the room for competition in each element of the system, but we want a split system from a commonality structure to a reasonable number of defined standard functional components, including platform, where we can achieve interoperability and open for competition, not just between these three big vendors, also for universities, small niche companies, small software providers, so we can always pick the best of the brand when it's available, so we don't have to wait 8, 10 years (inaudible) from the current vendor.

MR. HEYECK: Anyone else want to --

MR. LITVINOV: Anyway, I'm going to try to ask a personal question to Eugene so that I can also say something about open architecture. It's open architecture versus open source. They're a little bit different concepts.

When we talk about risk-based

calculation, it's actually a very formal definition what we mean by this. And today, we assume that every contingency is going to happen no matter what. We don't really put any kind of probability on it even though some of them are very unlikely to happen.

And based on some of our experiments, if you create an index, for example, that is a function of severity and probability, you can base your optimization on risk rather than contingency analysis or security. It turns out that the system becomes a lot more secure on average.

And if you'd like I can refer you to a couple of papers that we have. If you give me your email, I can send them to you.

Thanks. Oh, I'm sorry, just one more thing that I'd like to -- we talk about many different things, like flexibility and resilience, but we don't really come up with a very clear definition of what we mean by this. So, if you want to talk about these kinds of concepts, we need a formal definition, almost the same as we have today for reliability.

We have a clear definition of what we mean by reliability, but when we talk about flexibility we're just waving our hands. So what the R&D today is doing actually is trying to define what that necessarily means, how you measure and how you design a system for flexibility.

MR. O'BRIEN: I'll take a shot at part of the answer to your cloud question.

I think cloud is to IT what smart grid is to our industry, which is we don't all know yet. And I think having said that I think we've got to walk cautiously in the cloud.

You know, there's the private cloud, and there's the public cloud. Private cloud is taking advantage of the thinking that goes in the cloud but doing it within your own walls or within a set of walls of people that you trust.

I think we operate at great risk if we're pushing important operating data out onto the cloud, and we don't know how it's being secured and how it's being managed. So my two cents there would be walk cautiously, and we all really need to kind of develop what our cloud strategy is. And I'm sure each of the ISOs and each of your companies is probably doing that.

Then I'll follow up just quickly on how do you get there because that's the greatest question out there and it's the hardest one to answer.

I think the one thing -- and this is where at least my going was with the integration architecture -- is I don't believe that the three to four EMS vendors that are out there supporting us right now can do it all. And I think that how we get there is to have an architecture that drives innovation much more broadly than those three or four companies.

And the reason I don't believe that those three or four companies can do that is I don't think they have the funding and the research in those areas to actually do it.

And if we can open up the architecture

enough to allow others to compete -- and what I mean by that is there's been a lot of work done in some of the Seagray efforts and some of the very large power grid operator efforts, where they've really tried to put together kind of a reference architecture. But I think at the end publishing the integration patterns between applications and then asking vendors to develop to those standards is what makes sense.

But I think we need to recognize that those standards are a point in time and they will need to change as we evolve.

But I think opening up competition beyond the big three or four is one of the ways of getting there, but I'm sure it's pretty incomplete.

MR. PODMORE: Yeah, how to get from here to there, obviously, is the key. And I think the information model manager and the fact that people are starting to share them -- there's two things happening.

About 10 years ago, all the models were

very proprietary to the EMS vendor, and so utilities would spend anywhere from 5 to 50 man years building their model. So, if you came along as a third party supplier and said, hey, I've got this great application, there was a Catch-22; they didn't want to spend all that effort. And another Catch-22 is you had to get around as an EMS vendor.

And I was involved in getting ESCA started. To prequalify for a job, you had to have three installed systems that had been running for five years. So it's kind of hard to let new people into the marketplace when you have that Catch- 22, but in our case we had some customers in Texas that always try new things, and they happened to give Alstom -- ESCA a chance.

But the thing that will change is that by adapting the exact things we talked about in the October 5th meeting, where you model above the model and all the graphics can be loaded -- can be transferred to a third-party vendor. And that third-party vendor can say, hey, my application does all these really good things on your system. We will start lowering those barriers, and so those vendors will be able to show that their tools really work.

And we've had that in planning. The PSSE format, the PSLF -- literally, people filed the form 715 with FERC, and you could always download that and show that your software would run on the planning models for the entire interconnection. And so, we've had new players come into the planning space and do very innovative things.

So, on the one hand, let's assume that the October 5th meeting is going to go ahead. And we'll have an eastern model. We'll have a western model, a Texas model. And again, through the EPRI common information model, which is now an ISE standard, people are sharing not only the data of the model but the data of all the displays.

So a utility will no longer have to spend any effort to support a demonstration with a third-party vendor. Literally, you'll just give that vendor access to your files, and that vendor will show their application running on your model with all the displays.

But, of course, what has happened since 9/11 is the sensitivity of these models has become super heightened. So, whereas in the past you could download these forms from the FERC site, now you have to -- as vendors, we have to go through security background checks, if we've got -- you know, if anyone has a record, that's a problem.

So what we're seeing is the universities are reluctant to do the background checks on their students, and so universities are getting shut out from doing research on real models.

The labs have always been involved with hypersensitive data, and so the labs can participate.

So one of the things we were proposing is for training operators we have used a hypothetical system, and you can learn a lot from a hypothetical system. So our proposal now is for pure research, where you don't want to have critical electric infrastructure information, make up a model for the State of California or the State of Washington where you serve all the loads, but you do it with a set of transmission lines and a set of generation which is purely hypothetical, in the future.

And things like -- you can literally create a scene, a project, to use Google maps to say, okay, make sure you route your transmission lines through the mountain passes and respect the topography. And, literally, in a day you could have a reasonable hypothetical model, and then that hypothetical model can have 80 percent wind generation with a lot of combustion turbines standing in the wings and loads that you can control hypothetically.

So that was the thought there of creating those hypothetical systems.

The comment on the open source -- once you have this architecture, sooner or later some vendor will decide that they will use open source as a strategic advantage, but again, that can be done by that particular supplier.

I think --

MR. COWART: Okay. We have the wonderful situation of having so much interest in this discussion, and I'm going to -- I've written down everybody's names sort of in order. I'm not sure we'll get to everybody, but we're going to work down the list.

The first three are Clark, Dian and Susan. So, Clark.

MR. GELLINGS: Thank you. I'll be brief. Clark Gellings with EPRI. I wanted to react to the notion of whether the dominant focus should be central or decentralized. I don't think we can decide that. I think it's going to be both.

I think we're going to see a dramatic increase in the level of flexibility that we're going to need for the future. This is very obvious. It's obvious to me, maybe to others.

It kind of reminds me of my own personal unknown appliance story. When I used to econometric modeling for the utility that Dave and I work for, I used to go into the commission with my unknown appliance, and I would get torn apart and beaten because they would -- you know, you could imagine the dialogue:

Mr. Gellings, would you define the unknown appliance?

Well, I can't. But, dammit, if you look back just years and think about what we have no in terms of end-use devices, including onsite generation devices that are showing up in significant numbers, we did not see those years ago.

And so, what I'd like to add to this conversation is we have to be so flexible as to allow for technologies that we can't even now really envision as we think about this next generation of EMS.

Thank you.

MS. GRUENEICH: Did you want to talk? Dian Grueneich, consultant and previously a commissioner with the California Public Utilities

Commissions. Two quick questions: Are there other countries that are doing a good job of having developed an R&D road map and then looking forward?

And the second one is this whole integration of the DMS with the EMS, which is basically the technology of looking between the distribution side and the transmission side. In California, we're obviously embarked upon a huge amount of renewables combined with a huge amount of distributed generation, much of it on the customer-owned side, combined with very aggressive policies on demand response and then some level of where the energy efficiency will play in this.

Can you really have a smooth -- I guess it's almost two parts.

Can you really have sort of this very robust EMS architecture and infrastructure coming in without simultaneously developing the next level on the DMS side, if you are going to really make use and do it cost effectively and reliably, of customer side distributed generation and DR?

I'm not an engineer, but it strikes me in the little bit I've heard. It's almost like you've got that blank box in the middle. And I, as somebody who's always been very much in favor of developing the demand side, worry a great deal. Unless we have as the project, not say this isn't big enough, to also really look at the distribution management system, we may not get where we need to get.

MR. RISTANOVIC: Let me tackle this one, and I'm going to be very careful about what I say because there are some in California that like direct link to wholesale, some like through DMS, some like through micro grids. So we have to be ready for all of that.

So, for us, micro grid or DMS should not be different. Or, aggregator or single house. We have to hope for the best, which is let's say everything comes to DMS so we have a very limited number of points, or for the worse that every demand response aggregator comes to us directly.

So this architecture has to be built to

cover all possible scenarios, from the best to the worst and in between. And we don't see our role, you know, advising somebody out there to go the one way because it's more appropriate and easier for us to solve. We just have to let that play out there with all the stakeholders and be ready for the worst case scenario.

About R&D globally, in other countries, we are probably besides China the biggest country that can look into this problem centrally. But all these three, four major global players are doing this business everywhere, worldwide. These are all global players.

And SCADA systems and EMS systems are not that different across, you know, the scale. That's why it's very important to tap in on that huge investment in all those projects because the size of the business is probably in the range of $800 million to 1.2 billion a year. And if we can get some part of that global investment into a platform that is flexible and can be used to open competition for third- party players, that would be a big boost for the whole industry.

MR. LITVINOV: Talking about DMS-EMS integration, well, it's the volumes of demand response. For example, (inaudible) power plants is not very high. We can tolerate not knowing where they actually are.

Today's aggregators -- they don't have a concept of network models. Imagine if your volume of demand response grows significantly, without knowledge of the network, you can actually turn off all the consumers in the same phase. So you're going to create a very serious problem from an electrical perspective.

That knowledge has to reside somewhere. So you either put the distribution company somewhere as part of that loop of demand response or the distribution company becomes the demand response provider.

Today, it's purely the business model that is completely obvious of the network. So we don't really know where demand response sits, and we have to come up with some special ways of doing these things.

It is not only visibility but also the ability to create coordinated applications, and I can optimize voltage by coordinating between distribution level and transmission level. So it's not just providing information but also the ability to run the application in orchestration rather as two separate entities.

MR. O'BRIEN: And I'll just add one thing to the integration question. I think we are going to have support all types of integration, and it's going to evolve over time. But getting visibility in the control room, of what's going on behind the meter, is going to be important, especially if there are incentives for things to be going on behind the meter so you can properly forecast.

I think you'll see advances in the measurement and verification of not just demand response but the distributed generation and some of the other things.

I also think that we shouldn't rule out

profiling. That's one of the things folks don't like a lot sometimes is profiling, but I think in the short term profiling can give you a pretty good view of where you're at. If you can get in the 95 percent range, that would be helpful. At the end when you settle, you have to settle based on actual meter reads and all of that.

But I think the reality of it is until all the smart meters are there, until all of the infrastructure is there, it's going to be a combination of efforts to get that visibility, but the visibility is going to be very important.

MR. PODMORE: I think we're all implicitly saying that the entire system becomes monitorable and controllable right down to the -- so we're taking the fact that we're very used to monitoring and controlling everything at the high voltage level of 115 kV and above. And Ralph summed it quite nicely by saying to go down to the customer transformer and to go down to the appliances we just need to take technology and scale it by 10,000 times. Okay.

MR. COWART: No problem.

MR. PODMORE: So -- because we'll have two-way flow of power. We'll have islanding situations, and now in a restoration drill we might have 50 islands. In a smart grid restoration drill, we'll have thousands of islands because all those communities won't be waiting two days for the power to get through. They'll have someone out providing a service to give them the very minimal amount of power, which is your laptop and your cell phone. Okay.

So I think that's implicit, and we're saying that the past generations haven't been built to scale to millions of points.

And we see Google Earth is doing large databases, but they don't have the real-time data flow on top of that. So we know we can do it from a modeling point of view but not in real-time control.

And I think this forum is very good, to have actual commissioners or even recovering commissioners involved, because you can help us understand the case.

Right now, in California, in Los Angeles, there's a really big problem there. When you have a fault, the voltage drops and all those single-phase conditioners, what they do is they stall. And in that stalling process, they draw five times the normal current.

Now it's kind of crazy to build in all the transmission capacity to handle the event of all those air conditioners stalling. So why not give them a little signal to get onto the net and say, give me a credit, a dollar, and I'll let you turn my air conditioner off for 10 minutes.

And we're starting to see that. At San Diego Gas, they're saying if they have a high peak coming up, they will actually give customers a credit for taking less load than they would on a normal day.

So I see that. I think it's implicit. We're talking about not in EMS or transmission.

We're talking about a grid management system down to every appliance that can be controlled.

MR. COWART: Sue.

MS. KELLY: I hesitate to even ask a question of this group because the brains are so big, but I am concerned.

I mean, just last night, my members and I were basically lectured to by a high federal official about the severe cyber security threat we are all facing. You know, cyber 9/11. You need to be very concerned as electric utilities. We need to work together. We need to share data. All of which I will take on faith is correct.

But then I come here, and I hear about open architecture, open source, you know, put it in the cloud. And my arts and sciences background says to me, are we making ourselves more vulnerable by doing that because instead of having discrete -- and sometimes proprietary can be good in a very perverse way. You know.

But I'm just a little -- I'm very concerned about the cyber security aspects of this and just wanted to share that. And it sounds like some of you are already onto that, but this is going to be a very difficult sell unless you can really make that case -- that this is not going to cause additional vulnerabilities.

MR. PODMORE: Well, I think when we had the October 5th meeting, Vicky VanZandt from WECC was there, talking about what they've been doing with the Harris and Cisco private network that is also used for the FCC.

So when we talk about cloud, it's more like the software architecture. The idea is utilities have tremendous resources to host a secure set of servers in a bunker and have their own private network running across that.

So, when we talk about cloud, we're more talking about software that -- well, it can run with encryption. It can be a virtual private network. But the idea is that that architecture is able to support service with access by thousands of users.

But I think your point is very clear, that the whole issue of cyber security is a very serious threat.

And again, one of the things -- it's hard to find where do you go. In the defense industry, people have security clearances. So they clearly have ways of bringing the thought leaders together with those security clearances to address those issues.

Right now, it's hard to find that forum to look at combined physical and cyber attacks and how to do the defensive mechanisms for that.

MS. KELLY: Well, maybe when we grow up, we can get some clearances too.

(Laughter)

MR. COWART: Our next three Committee members are Merwin, Barry and Chris.

MR. BROWN: Thank you. Merwin Brown, the California Institute for Energy and Environment.

I have a lot of questions I'd like to ask you, but I'm going to ask one that is sort of philosophical, about where you think EMS is going in functionality.

I see some tensions coming into the play that are going to require some decisions about what way you are going to go in using EMS. By that, I mean up until now one of the ways we handle reliability is through margins -- the N-1 margin for contingencies, the thermal margins for thermal overload and then the dynamic stability margins for the big stability problems, and so on and so forth. And that leaves capacity on the table.

And then, there's another tension that says we won't be able to keep building capacity the way we want to in transmission, and so there's pressure to want to use as much as that, so to speak, stranded capacity as possible.

And there are also tools being developed that say we maybe can do that by relaxing the contingencies and start working more in the margins, using various kinds of probabilistic approaches and risk assessments and things like that.

So I guess my question is, do you see

the EMS as a tool that is going to either just barely maintain the status quo and maybe even will be putting in more margin as we go forward and more problems crop up, and therefore, having to build more infrastructure just to keep even?

Or, are we going to use new technology and start operating the grid in what I'll just loosely call maybe a higher risk mode because we will know more about it and have the capability to respond to changes faster? For example, rather than an N-1 contingency, you have something less than that because you can use your various analytical tools and other flow control tools to handle emergencies when they come up rather than have to have a margin of safety built in.

So this is to sort of help where you think this design is going, I guess.

MR. RISTANOVIC: Well, any moment, I can get the call here; the system is out. And do you think that -- you know, probably if you ask us, do you have 95 percent probability of that going out, or 98, or 99?

Our systems work on a single incident. When that happens, the guys who are in charge of systems are responsible for that single incident. Nobody will tell them, hey, for 5 years or 10 years they haven't had an incident. This is a single one, and it's too bad.

So who's going to accept a situation in which they're going to work on probabilities?

So I doubt that you'll ever see that. Now that doesn't prevent us from efficiently using what we have, and I'll just give you one example of what you're looking to. We have a lot of stranded capacity in transmission, and it's very difficult to build transmission, and we are very cautious to use the transmission, especially thermal limits. So we can introduce a new function like dynamic thermal line rating calculation and increase capacity of the transmission that we're not using today.

So that, yes; the other one, no.

MR. BROWN: That does have a certain probability.

MR. RISTANOVIC: No, that doesn't have a probability. What we are talking about -- dynamic thermal line rating is accurate, span-by-span calculation. What is the (inaudible) the transmission piece?

We're not talking about probability like wind on this span is 10 meters (inaudible) the coverage. So that is normal.

We're talking about accurate span-by-span critical span calculation and the determining the thermal limit of that partner.

MR. BROWN: And persistence. You have to estimate persistence, and that's where the probability comes in.

MR. RISTANOVIC: Yes.

MR. COWART: Barry. Oh, there's one more answer here.

MR. LITVINOV: The problem is not lowering the margin, but would you increase the margin beyond a certain point if you could lose a large amount of megawatts.

And somebody talked about the actuarial

approach to this. We need to understand what we consider to be a low frequency, high -- I mean low probability, high impact events and where do you stop where you actually take probability into account or not.

It's not anymore as clear as it used to be, where you said I'm going to have reserves. So, if you react, increasing reserves on anything that could be uncertain, you'll have a very, very expensive system to operate. So we need to come up with some ways of dealing with that and not necessarily just by increasing margins.

MR. HEYECK: Let's go to the next questioner.

MR. COWART: Right. I have Wanda and Tom.

MS. HOFFMAN: Barry.

MR. COWART: Oh, Barry.

MR. LAWSON: Thank you. I wanted to echo first something that Sue mentioned about cyber security. I would say that I can't see any of this moving forward without that being part of the design and especially, you know, even before the manufacturing stage.

MR. COWART: All right.

MR. LAWSON: I think it would be a nonstarter in our environment here, at least in the United States, and I hope that everyone realizes that -- that we can't move forward at all without that being a factor and being addressed.

The other question I have is related to something that's been talked about a little bit here, and that's the relationship between I guess the EMS system for the transmission, or the bulk power system, and then the distribution side of things.

Not all utilities are out there operating a bulk power system and a distribution system. There are many that are operating just a distribution system, and that's what they're responsible for.

So I'm curious. Are we talking primarily about an EMS system for the bulk power system, or are we talking broader -- broader than that -- because there are some very different issues in play here?

I'm thinking we're talking more bulk power system, EMS level, at least initially. But if we're also talking distribution systems, then I think we have a lot more issues to talk about, including costs.

MR. LITVINOV: Since I start this whole -- opened this whole can of worms, I'm going to try to answer it.

First of all, not every actual distribution company has a DMS today. Most of the systems --

MR. LAWSON: And they don't necessarily need it.

MR. LITVINOV: They didn't need it before. Now they may actually need it because in order to be able to actually keep track of all these distributor sources. You may not have a choice but knowing where they are.

So, from my view, my personal view at least, is that it doesn't matter whether it belongs to the same company or not as long as you have a way of communicating between distribution and EMS, which is standard, if you will, that you can come up with and knowing what kind of functions you will prefer. It really doesn't matter whether it's the same company or a different company.

MR. O'BRIEN: I want to make a comment on the cyber issue because I think the issue is much, much broader than cloud. It's much broader than all of that. The risks exist today in the systems that we have.

And I think that your concern is good. I mean, I think we all need a healthy dose of paranoia when it comes to that.

You know, I think what you're seeing more now is a lot more focus on building security into the architecture, building it into the design. The time to look for vulnerabilities is not after your system has been running in a production environment. It's what type of penetration tests are you doing in advance of systems going in.

And we have as big of a legacy issue as we do a going forward issue, but I think that's what the focus really needs to be is essentially a risk-based defense in depth. And I hate to use those buzz terms' strategy because there's an infinite amount of work we could on cyber security. And we really need to look at where are the biggest risks and are we doing the right things.

It's multiple initiatives. It's not just, you know, the cloud. It's what's happening to your email systems. If you've gotten any details on some of the penetrations that have occurred, they're really nasty and they're very ugly and we wouldn't want those happening on power systems.

So I think we all have a responsibility to be looking very hard at it, so we are.

And I'm with you all the way. I would put supervisor control -- in the cloud yet. I would not be controlling that at this time.

I'm not saying at some point it couldn't be secured and you couldn't have those things, but those are the decisions that we need to make in terms of cloud is good for some things; it's not good for everything.

MR. PODMORE: Well, I think there's an inherent issue with N-1 because that was built before the idea that there could be coordinated terrorist attacks, which gives you N-12 quite easily. So, really, it's the physical attack plus the cyber attack that is really scary.

And as long as we do not have direct load control where we have to open that feeder breaker and turn off the hospitals, the police stations, we are very vulnerable. And Secretary Chu calls this the slam-down-and-isolate approach.

So the way to truly get security is to elegantly keep the important loads on and turn off all the critical ones, and that's simply direct load control and then giving the customers an incentive and having the communications in place for that because that way we can get off all the noncritical assets and keep the really important ones on.

MS. REDER: Wanda Reder, S&C Electric Company. This may be more a point for future consideration, given the time that we have for discussion, but we opened the EAC meeting today talking about institutional barriers and cultural challenges. You know, I really think this phase is core for the transformation on how we handle centralized, distributed, cyber and -- you know. The list goes on. A lot of good points that were made by the panel and others as well.

But I look at this and say, we're a highly conservative industry for a really good reason.

And I want to put ourselves in the space of if we had the perfect technology. Can you comment a bit on what it's going to take to move us from a cultural and an institutional perspective so that we can get there, get the people and get the organizational processes in place in order to make this happen?

MR. PODMORE: Well, there are a couple of examples where they did -- I was involved in the Common Information Model Standard. And Russia picked it up and implemented with a single vendor throughout the entire country very quickly. China picked it up and implemented it very quickly.

But I think Anjan brought up what he called the ENTSO-E, the European grid operator where they had many vendors, many countries, and they literally had a committee come together.

So I think continuing to have these types of meetings where you really get the technologists, the Secretary of Energy, the public utility commissioners -- we can make this happen because this is the start of something that follows the American process. And I think it's players at all levels, and we haven't really had a forum to really have players at all levels get involved.

And the whole issue of NERC, it's had a tremendous impact on the industry. They're trying to be a kinder and gentler face and really educate people well. I mean we have some of the best minds in the industry coming in and educating us on human factors.

So I think this process where it gets to the very highest level -- and clearly, when the Department of Energy calls a meeting, everybody makes a really definite effort to show up.

So I think this is the democratic version. And we can get things going quickly, and we can get the best minds in this industry working on it.

MR. SLOAN: Thank you. Tom Sloan. I'm a state legislator in Kansas.

And I'm probably being obtuse this afternoon, but I'm still struggling with what the DOE and state roles should be, moving forward, relative to the RTO/ISOs, the utilities and the vendors.

I mean, what are our actionable items, at least in the near term?

MR. O'BRIEN: I'm not sure I should answer this. Maybe somebody from the DOE should.

But I mean, from my perspective, I think the actionable items are to identify the things that can make the biggest difference, make investments and support investments in projects in those areas, and then stop things that aren't providing that same value -- that if you have a project going on and you realize that it's water that's not going to the right place, stop it.

But I think -- at the end of the day, I think DOE really can help with investment, and I think that investment really comes to not just pure R&D but pure, pure R&D leading the implementations because the real value is in the implementation. You can do the best research in the world, but if you never implement it -- that's just one perspective.

MR. LITVINOV: Again, I'm not absolutely sure what the jurisdiction of the R&D could be, but with so many labs that could be directed to do some R&D that we lack in the industry. We have very low R&D levels in the industry today, and I have no idea how to increase it.

But the labs, with their capabilities, could increase the amount of research that is specifically directed to our needs. And the way to make them aware of this is having some forums that we had just recently with Secretary Chu, discussing high performance computing and some other similar discussions, where they are actually aware of what the needs are. It turns out that most of the labs have very little knowledge about what our systems need today.

MR. PODMORE: I think one thing that is changing is as engineers we would always get together and complain about how the lawyers and the accountants are running everything. And they dominate FERC. They dominate the PUCs. But we have not done a good job to really be leaders and clearly explain.

And I think Wanda has been a great leader for our industry.

So it's really that two-way communication. As engineers, we have to make a much better case about why we think these technologies are important.

As regulators, you have to -- none of this has to be a mystery. Okay. As regulators, it's really good that you start understanding what would be the benefits of my company having PMUs when they come to you in a rate case and say we want to install them.

So it's just keeping this sort of dialogue going, which has to be done from the very highest level because, clearly, it is such a critical infrastructure for our country right now.

MR. HUDSON: I want to -- I put my card back up because of something that Robin said about the response to physical and cyber attacks. I had it up earlier because I was interested in the question that Dr. Litvinov raised about centralized versus decentralized and intelligence in the control system.

And one of the things that I have wondered about for a while is whether a system that has more decentralized control is a system that is potentially more cyber secure or could be made more cyber secure.

And so, I'm wondering whether there is a piece of R&D that could be recommended to the Department that would actually begin to answer that question. And, if so, do you have suggestions about how it might be structured?

And then, assuming the Department undertook that R&D, what impact would it have on the development of next generation EMS?

MR. LITINOV: My name was mentioned in that. Yes, I would say that not only cyber security-wise but also resiliency-wise the decentralized -- and again, I'm not advocating to create a fully decentralized system. It's just impossible. Always somewhere in the middle is a hybrid.

And again, the reason we didn't talk too much about cyber security is because we agree with you that this is very important and in every single design that we do we take into account the cyber security.

And, in fact, the cloud was created

initially with a different design in mind. And because virtualization and the cloud getting so more used in other industries, the security is going to come.

The reason cloud is cheap today is because certain things were ignored. It's not so much security as much as the integrity of the data.

You don't care if you're looking at Amazon and somebody sees that book appear in Amazon and you only see it 10 minutes later. Well, we do care about this, but if you create a special state estimation logarithm that could take care of this or account for this, you may actually build up the case the work off the cloud.

And nobody said that we could just drop everything in the cloud and hope that it's going to be secure. Nobody is going to do it until we know how to do security of the communications.

The same thing if you go decentralized; you're creating additional -- you may actually remove additional or some extra data exchanges that are needed otherwise for coordinated or hierarchical control.

So there's another hope that when you're sensing locally certain conditions, that you can actually provide service for the system, and some of the research is being done in this area that could give you much better resiliency, both from a cyber perspective but also from a power systems security perspective.

MR. COWART: So we are over time, but we have two persistent, smart people who are asking questions. So I want to allow that to happen.

Do you want your card out, or do you want --

MS. AZAR: No, keep going.

MR. COWART: I was going to make sure that at least Lauren had the last question.

MS. AZAR: Well, I was actually going to ask a question getting to the DOE's role and potentially what we could be doing vis-à-vis commissions and legislatures.

Let me ask -- and I think Anjan

mentioned this. One of our roles can be as conveners and as honest brokers. As a former commissioner I know that it was sometimes difficult to weigh through testimony from utilities, not knowing if what they were proposing was really needed.

The DOE actually could play that role. We could very, very deliberately go in and help, not intervene in dockets but go in and education commissions as far as the kind of things that are really needed; the same with state legislatures.

Is that a role where our resources would be well spent because it would be very, very time-intensive?

MR. VAN WELIE: Well, let me frame --

MR. COWART: Well, I was going to say let's put both questions up and then we'll get responses.

MR. VAN WELIE: Because I think it's almost a flipside of the same question, which is -- I mean, I think we're talking about trying to have someone, the DOE, make an investment in taking this industry from one level in terms of its architecture to another, which is a pretty dramatic step. It hasn't been done anywhere like this before.

The industry periodically gets bursts of enthusiasm and talks about this, and then it all fizzles out for the reasons that were described earlier, which is very thin margins. There just isn't enough money actually ever to make this work.

So my question -- the question I was going to ask to the group -- and it's really related to what is the DOE's role. I mean, the DOE in one sense could say let's play a facilitative role. I think that would be pointless, actually, because you might have a few meetings where people get enthusiastic and then it all fizzles out. This is only going to go somewhere if we're prepared to spend a large quantity of money for a long period of time.

And so, what I was interested in hearing from this group was, what do you think it's going to take? Is this a one-year investment? Is this a five-year investment? Is it a 10-year investment?

Just sort of orders of magnitude, in order to get the step change that we're talking about, what's your instinct in terms of how much staying power is going to be required here?

MR. RISTANOVIC: Well, DOE, no matter how much you invest, cannot build the platform.

So, if I'm thinking about doing something with this, I would define some requirements for ISOs/RTOs that will gradually become mandatory requirements, and I will give some credit to early adopters to move in that direction, which will probably move some vendors who want to move. So I would say three to five years you get a couple of early adopters of different elements of this new architecture. And you benefit from a kind of credit, like a renewable credit, for getting there as an early adopter, and supplement vendor investment, and that way you can get somewhere.

Building these platforms in a vacuum or in universities or in labs was never done before, and I know the complexity, and I know some vendors failed with trying to do this. And I was part of one of those efforts, and the numbers are staggering. I don't want to tell you a number, but Gordon has a pretty good idea of what I'm talking about -- the number of years and amount of money.

So, for me, that is the most feasible scenario, to gradually introduce mandatory requirements for flexibility and openness of these platforms and help early adopters with the funding.

MR. PODMORE: In terms of the time frame here, it's probably five years or so, but we are already seeing the impact of the Southwest blackout on very small companies. I had one in California that's a 200-megawatt generator, and they have a contract for, let's see, $2 million worth of support just to be compliant and do better operations studies and to do better real-time training.

So I think it's an educational process. I think we've got a very clear grouping of the NARUC committees. I really think it's an educational thing.

And what we're finding right -- there's been a history that people in operations tended to be very independent, very strong-minded and wanted to be left alone, and that is not the type of person that you need to build the relationships, to go through an audit and to kind of get the support. So we're now finding more and more people in compliance are saying, I've got this big box called operations and that's where all the fines are coming from.

So we're seeing that it's okay to justify operations and better tools through the compliance group and risk management.

And so, I think having the awareness through the compliance offices. The security offices are playing a role. As commissioners, you all have an impact at that level.

It all comes down to trees, tools and

training. Okay. And we know that over and over again. So as regulators and as utility executives, we're seeing a lot more interest in what is happening in operations.

MR. O'BRIEN: I would just add one thing to what these guys said. I still think there's a role for DOE to support targeted projects. I think there's been some real successes out there with it, and that's -- really without that, we wouldn't be where we are today with PMUs. You know. That's -- we never would get to the place where we could even do the analytics.

And we've still got a big hurdle, but I think DOE could play a role in that hurdle.

And I would say it from personal experience. Some of the work that we've done on a DOE-funded project around cyber security has been extremely valuable. So I think there's still a role for targeted funding by DOE.

MR. COWART: That sounds like a good last word. Would you all join me in thanking our wonderful panel?

(Applause)

MR. COWART: And I think before we adjourn, Elliot has got some final logistical announcements maybe.

MR. ROSEMAN: Yes, as most of you know, I'm Elliot Roseman of ICF.

I want to not only thank the members of the panel, but I want to thank all of you here for a very robust set of discussions this afternoon. We're, of course, going to be continuing that tomorrow, tomorrow morning beginning at 8:00 a.m. But the good news is, as most of you probably notice, we do have coffee in the room.

(Applause)

MR. COWART: Serious improvement from last time.

MR. ROSEMAN: I do want to thank really all of the EAC members and the subcommittees for the hard work that you've been doing over the last couple of months.

We have six papers tomorrow that you've received that we're going to be reviewing and discussing and, if you deem appropriate, approving.

We have ideas that the subcommittee chairs are going to be putting on the table with regard to plans for next year, for 2013 already, and teeing those up. So we're looking forward to your comments and discussion with regard to that.

We'll be starting, as I said, right at 8:00 with the Transmission Subcommittee, then Storage, and then we'll have an address from Commissioner LaFleur from FERC and continue on with the Smart Grid and the Workforce Subcommittees.

We do have the dates for next year. You may have seen one of the slides up there earlier. I'll just mention the dates right now. So, if we repeat them several times, you'll all hopefully put them into your calendars.

We will be meeting again March 6th and 7th, June 5th and 6th, and October 2nd and 3rd of 2013. The venue will be out at the NRECA offices, and they are in the Ballston area of Arlington, next year. So we won't be downtown.

So we have several events that are coming up, obviously.

And I want to mention very briefly a couple other important events that you may not have noticed. Very few of you may know, for example, that today is Rich Cowart's birthday.

(Applause)

MR. ROSEMAN: Wait, wait. Not yet, not yet.

(Applause)

MR. ROSEMAN: Not yet, not yet. Hold on. Very few of you may know that yesterday was Mike Heyeck's birthday.

(Applause)

MR. ROSEMAN: And I suspect that a number of you know that Sonny Popowsky, after 33 years -- I think that's right -- in your position as a consumer advocate in Pennsylvania, is retiring I think next week.

SPEAKER: No way.

MR. ROSEMAN: So I'm going to suggest

that we sing a little song to all of them. You've probably not sung a birthday and a retirement song. So let's do that.

Happy birthday and retirement to -- come on. Join me.

Happy birthday and retirement to you. Happy birthday and retirement, dear all of you. Happy birthday and retirement to you.

MR. COWART: Thanks, Elliot.

MR. ROSEMAN: And the last thing that I have to say is that when we took over this work in supporting Pat's group I suspect that one of the criteria that were used to evaluate ICF was not that we had a resident pastry chef onboard. Well, some of you were fortunate enough to get the cookies last time you were here, that Paula made. This time, our resident pastry chef has outdone herself and has made in honor of the birthday and retirement a carrot cake and a glazed lemon cake, which is available here momentarily to all of you over here at the desk. So, for those of you who want to have your dessert before dinner, please do so.

And thanks to you all for coming. We will see you tomorrow morning.

For those of you joining us for dinner, from DOE, from the -- and EAC members as well as the Workforce Committee members, we'll be meeting in the lobby at 6:15. Thanks.

(Whereupon, at 5:44 p.m., the PROCEEDINGS were adjourned.)

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

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Notary Public in and for the District of Columbia

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