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P R O C E E D I N G S

CHAIRMAN COWART: Okay, Committee members will you please take your seats? We are going to begin.

All right, good morning. Our first topic this morning is to hear an update on the QER from Karen Wayland. I see Karen's here.

MS. WAYLAND: Are you ready?

CHAIRMAN COWART: Yes, we're ready to begin with you, thank you.

MS. WAYLAND: Thank you for having me again. I think this is the third time that I've updated you and I think by now we thought that when we gave you an update in March that we would be holding up the actual final document. But I think that Sammy remembered me telling you early on that the interagency process would be the most difficult part of this endeavor. And, indeed, we did deliver the DOE version of the QER to the White House in January before the January 31ts deadline and we have spent the last six weeks or so in a very intense interagency process that's just wrapping up. And we're hoping to release the QER in the next couple of weeks.

It's going to take a little bit to get it formatted and laid out but we're largely done with it. The interagency process was quite good. We got a lot of really good comments from the agencies and so, it took some time to incorporate those into the report.

As you remember, we were looking at transmission, storage and distribution. That's not just wires and pipes but rail, barge, truck transport, waterways, that sort of thing. As I've been telling you through the last year, we divided up our analyses by sector. So we were looking at the electricity sector, the natural gas sector and liquid fuel sector and that at the interdependencies among those sectors.

But when we were done and the analyses we worked with our national labs, we worked with consultants. We had a large team within DOE both within EPSA and across the programs. And when the results of all the analyses started filtering in, we really started to see some themes. And so, you'll see that the QER is organized not by sector, although we will have some sector specific appendixes that will come out a few weeks after the first volume comes out.

We really were looking at themes that came out. And those themes are resilience, reliability, safety and asset security is the first theme, energy security infrastructure, shared transportation and then, grid of the future. And the grid of the future is the only one of those themes that actually looks at one specific sector. And that's because, as you all know, the electricity transmission, storage and distribution system underpins so much of the other infrastructure as well as our basic economy.

And we have some cross-cutting themes as well. We have a section on citing. We have a section on environment and a section on jobs and workforce. You can, again, I remind you that we're starting to release a number of papers out of the analyses and ultimately, all of the kind of work products that fed into the QER will be released to the public. We've posted a number of those, a couple of proceedings from a technical workshop on resilience metrics and we've posted a paper on modeling on the natural gas capacity needs looking out to 2030 on a number of different scenarios.

And those are -- you can find all of those papers as well as all of the proceedings from the stakeholders meetings at energy.gov/qer. If you look at the grid of the future, you're all well aware of the quickly changing landscape within the electricity sector, the massive injection of new, of innovative technologies and new services.

And so, we have an electricity system that is sort of an engineering marvel of the world but that's undergoing a significant amount of stress as a result of this unprecedented new technologies and demands on a system. I think you're going to hear today about the quadrennial technology review. And as we began working on the

QER and the QTR began, the people working on the QTR were working sort of in parallel, it became clear that what the QER should focus on is not on a research and development agenda but really looking at the institutional regulatory structures and business model challenges around these rapidly changing conditions within the electricity sector.

So what you'll see are recommendations really -- there's some focus on R&D and it's mainly through our support for the DOE's grid modernization crosscut. I can't tell you too much about the recommendations right now because obviously the document isn't out. But I can say, and the Secretary certainly has been giving speeches around the country where he says that the work on the QER did inform the FY16 budget request, so some of the things that you'll see in the FY16 budget request will be also reflected in the QER. Among those, as I mentioned, are the highlighting both the institutional support aspects of the grid crosscut but also the technology research development and deployment and aspects of that DOE budget.

A couple of other things that are in the budget, and again, the Secretary is very clear from the beginning that there is no one size fits all national policy for energy. We really have to be cognizant and acknowledge the regional characteristics of energy in this country. And so, you won't see one size fits all recommendations.

What we were trying to do is design tools and resources for the people outside Washington who are working in this area. So you'll see a large theme across the sectors for aid to states and local entities that have to manage and help regulate and develop our energy networks. So a couple of things that came out in the FY16 budget in addition to the crosscut were support for state energy assurance plans.

Those were set up under the Recovery Act. We funded, I think, almost all the states, maybe 48 or 49 of the states completed energy assurance plans. It's much more of a focus on emergency planning and it was a one-time shot from the administration because it was recovery funding. But we believe that those are really critical to helping the states maintain sort of electricity reliability, affordability and to recover and build out resilience.

So we have envisioned and the FY16 budget is a down payment on permanent funding so that states can update those energy assurance plans every two years as well as exercise, practice them and potentially, what we were hearing from the White House and from the outside stakeholders was that it would be great if we could actually make those energy assurance plans very rigorous and have some very strong criteria in there for what the plans look like.

And if we do that, it's possible that in the future, we can build out additional funding for say pre- disaster mitigation or other things that would rely on making sure that things are built out in the energy assurance plans. We also are in the FY16 budget created a program for state reliability, state electricity reliability planning and Pat's nodding. I don't know if she's actually talked about it.

But again, that's designed to give -- where the state energy assurance plans would be some sort of base like a formula, the state electricity reliability plans would be competitive and they would be preferenced (sic) for plans for proposals that come in that actually highlight the cooperation both within states and with neighboring states and also with the variety of stakeholders and reliability coordinators that are concerned about building out a transmission system that keeps our electricity reliable and affordable.

We've gotten a lot of interest from both the House and the Senate. You know, we were directed to do legislative proposals, budget and as I said, R&D but that'll be mainly the QTR and executive actions. It turned out that it was very difficult for us to come up with a large number of legislative proposals because you're in an interagency process. You have to work through the White House.

But we have -- our body of analysis can provide a lot of technical support to the House and the Senate when they build out their energy bills. And we've met multiple times with Hill staff throughout this process. And they are very interested.

I think if you look at the outline that came out of Chairman Upton's committee about what they're thinking about in terms of an energy bill, it largely fits into the number of the categories that we're working with in the QER. So we do expect that the report will lead to some legislative action.

In fact, we are scheduled -- we were scheduled several times in April for the Secretary to testify in front of the Senate Energy and National Resources Committee on the QER and as this process has been moving a little more slowly than we anticipated, we've had to move that hearing. But stay tuned for that because I think that'll kick off -- and you may know that the Senate Energy and Natural Resources Committee a couple of weeks ago had a hearing on the grid of the future. And the plan originally had been that they'd have a hearing on the grid of the future and the next week would be a QER hearing. But we're stringing them along a little bit much to everyone's frustration but we're almost there.

I have a fair amount of time left so I will talk about another one of the themes that we picked up on. And it was one that I don't think any of us actually expected to be both so interesting and both so critical to our energy system and that's shared transportation. And by that I mean not the dedicated infrastructure of wires and pipes but the kind of infrastructure, the roads and waterways and ports and harbors, where multiple commodities and not just energy, we are talking about multiple energy commodities moving this way, but basically the majority of the commodities, the commerce, in this country moves roads, waterways, ports.

And so, what we're seeing, we looked at fuel delivery systems. To some extent we looked at trucks and roads but we really looked at those mainly through the interconnectors with ports, so the roads and rail. We didn't spend a lot of time on roads. We looked at storage facilities, refined product facilities and one of the key questions that we were asking was what are the effects of the increasing use of these shared transport systems for moving energy commodities?

We're saying massive increases in movement of domestically produced oil but it isn't just oil. It's frack sands; it's actually waste water in some places. It's coal. It's ethanol. So it's these movements and increasing movements of product by rail but also in the waterways.

We're seeing an increased use of waterways for moving coal, for moving ethanol, for moving other energy commodities and that's happening at the same time as we're seeing an overall increase in waterborne commodity transport. We're expecting over the next 20 years to see a doubling in marine freight movement through our ports and all of this is resulting in congestion, delays, some increased price for moving goods around.

And so, we were really looking at what the effects might be and whether there's a government role in helping to address the changing nature of the movement of these goods on the waterways. We are seeing a significant maintenance backlog which I don't think will be a surprise to many people. I spoke a couple of weeks ago to the Association of State Highway and Transportation officers. And they are all grappling with these massive changes in the transportation system.

So we were really looking at what the effects are not just on the movement of energy commodities. You probably have heard of the four coal units in Minnesota that had to shut down earlier in the fall last year to wait so that they could stockpile coal for the winter. They couldn't get enough coal because there was so much congestion on the rail.

So these are capacity constraints that we were examining and they do have economic effects. The civil engineers have noted that the congestion and inadequate connections from port terminals to roads and rail are one of the biggest challenges causing delays and moving goods from ports into the markets.

So there are likely economic effects but we believe that there are potentially also some security effects and that's where we get into looking at energy security infrastructure, which for us, the majority of our work in that space was around the strategic petroleum reserve. And when you look at the original goals of the strategic petroleum reserve, it was set up to and it continues to have the objective of buffering the United States from massive oil disruptions.

What it was designed to do was before we had this huge increase in domestic oil production, it was designed to move oil from the Gulf Coast into the lower 48, into our domestic marketplace.

And with this change in production, what we're seeing is that the need is for -- and this was also set up before we had a global oil market. So what we're seeing now is a need for the strategic petroleum reserve to be able to deliver oil out into the global market.

So it's a complete reversal of the flow that we need the oil to move out of. That's happening at the same time that we're seeing a lot more product moving on the pipes that come down into the Gulf and in the tankers and barges that are moving around the Gulf. So we did a test sale of the strategic petroleum reserve a little over a year ago and have been evaluating the ease or the lack of ease of which we can move that oil out into the marketplace.

So you'll see some recommendations within the QER around how we might modernize the strategic petroleum reserve not only to upgrade the equipment that's there but also to look at how we might both legislatively and sort of structurally adjust what the strategic petroleum reserve looks like in order to better get market out into the global market.

I think with that I will stop and open it up for questions and hopefully come back to you at your next meeting and hold up the document and pass it out to you.

CHAIRMAN COWART: Well, we look forward to that.

MS. WAYLAND: Yes, so do we.

CHAIRMAN COWART: Any questions or comments?

MS. SILBERSTEIN: Good morning, Karen. I apologize --

MS. WAYLAND: Pam has been sitting through all of our meetings all year long. She flew all over the country and she's heard this spiel many times from me so thank you for sitting through it.

MS. SILBERSTEIN: Well, it wasn't --

MS. WAYLAND: And still having questions.

MS. SILBERSTEIN: -- me, it was a lot of

coop representatives so I hope their input was useful and I apologize if you mentioned this since I came in late but did you talk about the connection between the QER findings, the recommendations and budget impacts?

MS. WAYLAND: I did.

MS. SILBERSTEIN: Okay.

MS. WAYLAND: So we, as I mentioned, the QER did inform the FY16 budget and we expect that we'll be working very closely with the appropriators over the next few months as soon as we can release the report to figure out how we might fund other parts of the recommendations.

MR. ZICHELLA: Good morning, Karen.

MS. WAYLAND: Hi, Carl.

MR. ZICHELLA: I was struck by the fact that you didn't mention climate one time and so much focus on facilitating fossil fuel infrastructure which, of course, is part of the overall picture. But how does this fit in here? I mean, you said there was a --

MS. WAYLAND: Oh, climate is all the way

through it. It was a lack of coffee on my part.

MR. ZICHELLA: All right.

MS. WAYLAND: I mean, we really look at particularly the grid as an enabler for the President's climate goals. And when we, for example, did transmission scenario modeling -- actually all of our modeling was done under a variety of scenarios and we kind of pushed the envelope to see how far we could stress the system to see what it would look like as it evolved to 2030 to meet our needs.

And climate goals were always part of the scenarios that we looked at. And it turns out that so, for example, in transmission, long-distance transmission, we did modeling that looked at high and low energy efficiency, high and low natural gas, high and low; I'm trying to think what the other scenarios were. Coal plant nuclear retirements, we looked at a carbon policy not a specific policy but sort of a carbon target. And then, we combined those to see what the transmission scenarios would look like.

And under all of the scenarios, save the one where we combined high renewables or low cost renewables, strong carbon goal, a number of other things, we didn't see a significant amount additional transmission built beyond the business as usual case. Which is not to say that there won't be more transmission built out to 2030, only that when you actually run these scenarios you see some regional differences that develop.

So for example, if you push the envelope on low cost renewables, and we use low PV as a proxy, what you see is a regional -- you don't see very much difference in the business as usual but what you do see is, for example, less perhaps build-out in the southwest but a little bit more than you would see in business as usual in the Midwest to build out to connect for reliability issues.

So we were very much looking at, and even in the natural gas sector, I mentioned a study that's been posted on the Web that it looks at natural gas capacity. And that study, again, various scenarios to look at the interstate pipeline capacity. And we looked at low, medium and high demand for natural gas from the electricity sector and it turns out that even in the high demand scenario, which was modeled around a carbon goal that would lead to retirement of electricity generators, you didn't see that much more capital investment that was required than business as usual.

In fact, in the next 15 years, even under a strong carbon goal, you would see less build-out in the natural gas capacity system or natural gas interstate system because there's been significant investment over the last 15 years and there's a lot of capacity, excess capacity and flexibility in the system right now. So we absolutely were looking at climate and it's, you know, in 10 minutes and without coffee I didn't mention it.

MR. ZICHELLA: You just made up for it. I also wanted to just comment briefly on the strategic petroleum reserve things you just described. I was surprised by that given, you know, the focus on climate as well. The export situation seems like that's still a political and not necessarily a clear cut decision. There's lots of opposition to exporting --

MS. WAYLAND: Yeah, but this isn't about lifting an export ban. This is about the strategic petroleum reserve in emergencies. And so, there is statutory authority to actually sell the strategic petroleum, the oil in the reserve. So it's not a -- it was outside of whether or not you would be exporting domestically produced, I mean, this is domestically produced oil but it's not the same. It was under emergency situations.

MR. ZICHELLA: Okay, great, thanks for that clarification.

MS. WAYLAND: And there's a whole -- in the statutory language for the strategic petroleum reserve there are triggers that allow the President to sell that oil and one of them is for a test sale to make sure that the equipment's working but then there are a series of kind of price shock issues and around there.

It turns out that we have -- we did look at fuel resiliency. We did a series of regional fuel resiliency studies. And it turns out that if you look at what the triggers are for the New England home heating oil reserve, they're not the same as the kinds of triggers that you would have for the strategic petroleum reserve.

And we were looking at whether that made sense in this environment. Whether you needed separate triggers for the different reserves that we have. So --

MR. ZICHELLA: Thank you.

MS. WAYLAND: -- yeah.

CHAIRMAN COWART: Gordon?

MR. VAN WELIE: Good morning. I just wanted to come back at your comment about the pipeline study and I found that interesting and it makes it --

MS. WAYLAND: Except in New England.

MR. VAN WELIE: -- well, so my question really was, I mean, you've learned some things in

New England.

MS. WAYLAND: Yeah.

MR. VAN WELIE: So you know, the conclusion of the study was looking back 20 years, we built a lot more pipeline capacity than what we think we're going to need looking forward 20 years and that the industry is perfectly capable of building enough pipeline to meet the need. And I accept all of that.

MS. WAYLAND: I don't think I said perfectly capable.

MR. VAN WELIE: Okay.

MS. WAYLAND: I mean, we acknowledge in the study that there are siting issues and but that they're not insurmountable.

MR. VAN WELIE: So setting aside the siting issues which are non-trivial, I thought the study missed one thing though which was most of that pipe historically was built under a vertically integrated utility structure where the state regulators when they bless the power station, they could also bless the fuel supply and roll all of that into rates.

So I think the challenge that's emerged and we're sort of at the forefront of that challenge in New England is that in a restructured environment, merchant generators typically will not sign to build this pipeline. So I think whereas the industry is capable of doing this, the question is who's going to sign up to get it done.

MS. WAYLAND: Right, right. That's right.

MR. VAN WELIE: And I was wondering if, you know, the QER is going to highlight that problem?

MS. WAYLAND: Yes, we do. We do. In fact, we do actually have a vignette on the situation in New England so we do. I would say another thing that Kate highlighted to us. We started thinking about storage and the changing nature of storage in this. You know, where you have a price differential that used to drive investments in storage and perhaps with a greater reliance on natural gas, you may need more high deliverability storage.

But if you're seeing more natural gas being used in the summer for generating and keeping houses cool, you know, you see electricity spike during the summer, what does that do to the price differential on natural gas and what does that mean for long-term investment in storage? And so, that's one thing that became clear to us that it was -- and we asked a lot of questions about storage around the country about to experts and they were only just starting to think about the implications on storage.

So something that we focus -- we didn't focus on, we are raising as an issue to pay attention to.

CHAIRMAN COWART: Nothing further? Once again, thank you very much.

MS. WAYLAND: Thank you.

CHAIRMAN COWART: Committee members will remember that yesterday we were unable to hear from Jeff Taft as part of Clark Gellings' panel and Jeff was able to make it this morning. Thank you. I'm glad you're here. And Clark, to you.

MR. GELLINGS: Thank you. Jeff, you only get a brief introduction even though you came late and may have been looking for more star power out of this but I'll give you about the same length of introduction as I gave everyone else.

What Jeff is going to add to the discussion that we had yesterday, we had an excellent panel, I think, is more on grid architecture. Jeff Taft is the chief architect for electric grid transformation and energy environment in the Pacific Northwest Energy Laboratory. Long list of accomplishments but basically responsible for the development and articulation of large-scale architecture for grid modernization as well as the future power grid initiative, advance computing and the control of complex systems.

He's had similar roles roughly with Sysco, Accenture and IBM. And so, Jeff, please, we're anxious for you to share your thoughts with us.

MR. TAFT: Well, good morning and thank you for accommodating my travel misadventure yesterday. I actually live near Pittsburgh and I come to DC all the time on a flight that's only 40 minutes long but that was the longest 40-minute flight I've had in some time. They took us to Richmond and bused us back up here just in time to miss this whole meeting.

What I would like to talk about today is some work we've been doing on system architecture as it applies to the grid. And I'm going to give you a little bit of background and history on where this comes from and then, show you a little bit of the work that we've been doing and how this applies.

The reason I need to give you some background on this is because the word architecture gets used a lot and in some ways incorrectly and some ways correctly but with a slightly different slant and orientation. This came about because we realized that a lot of the methods that people were using applied to the grid weren't powerful enough to deal with the emerging complexity that we saw.

And so, just to be clear, what we mean by a system architecture is a model of a complex system and we use it to help think about that system especially about the overall shape of the system, if you will, the overall structure, the attributes and how the parts interact. And we'll -- you'll hear me talk a lot about structure when I talk about this because it is the structure that sets the essential limits on what a system can and cannot do.

We've inherited a lot of structure from the 20th century grid and in some cases, we need to make changes to that to enable new capabilities. And it's important to understand the implications of those changes. We have such a complex system that I understand it can be difficult.

So we use this discipline in general to help manage complexity and therefore risk. And we also use it to help assist communication amongst stakeholders. When something is this complicated you can find people easily talking past each other. So this is a way to help solve that.

And I already mentioned about barriers and essential limits and so on. And it also helps us identify gaps in theory and technology, organization and so on. We can use it to find interfaces and platforms and finally enable prediction of system properties on a rigorous basis.

The discipline arises from work in various areas. Some of it goes back into activities done by the Department of Defense but a lot of this comes from places like Cal-Tech and MIT, CMU and other places and we're doing some work now at the Pacific Northwest.

What's in a system architecture? Well, first of all, there are abstract components what -- those are the boxes that you would see on a typical diagram but we don't worry too much about what's inside the boxes. We treat them as sort of black boxes and the idea is that we're concerned about how they look from the outside about their properties but not how they're implemented.

So if I talk about, in the architectural level, I talk about storage, I'm interested in how it looks to the system but not how it's implemented. So it doesn't matter to me whether it's a flow battery or whether it's something else. That's left to the system designers and part of the issue with architecture is not to encroach on that area and tell people how to implement things. That's not what this is about.

That being said, we have to be a little careful that we don't specify things that aren't for real. So you've seen this cartoon before right in the middle there, it says that a miracle occurs. Well, we're not allowed to do that so sometimes we do have to understand and investigate a little bit about the components and understand what's possible so that we don't find ourselves trying to specify something that really couldn't happen. So I usually say no anti-gravity boxes but this cartoon sort of says it there.

Structures, as I mentioned, are a thing that we focus on a lot. They're the overall shape of the system if you will. A lot of that is nicely depicted graphically but, you know, a simple diagram, a block diagram or some boxes and lines does not rise to the level of an architecture. There's an awful lot more to it than that.

It is not possible to depict a complex system with one single diagram and so, somebody shows up and says, hey, I've got an architecture for the grid and it's only on one page, you should probably be very concerned that maybe there's not enough there. There are a lot of things that we have to think about. There are a lot of structures and in the case of the grid, as you can see, that becomes a significant issue for us.

Finally, there are the externally visible properties. The components that we talked about have properties that we see from the outside. So do the structures have properties and those are really of a lot of interest to us and, of course, those come together to create the properties of the entire system.

So when you think about that, when we think about it, we think about it in terms of system qualities, those things we want the system to be able to do kind of seen from the perspective of the users. And then, the properties of such a system that are necessary to provide those qualities.

So if you think about it, structures and their properties, components and their properties combine together to make system properties which support what we call system qualities. Some people refer to the qualities as, you'll hear this term, the "ility" words. And there are a lot of those that get used in this area. There's actually some distinction between which ones belong in the property area and which ones belong in the quality area.

Well, the system architect helps sort that stuff out. So when we think about creating an architecture, when we compose an architecture, we start from the problem domain side. What are the user's needs and what are the public policies and so on? And we think about then what qualities should a system have and then move to so how do we compose an architecture that's going to be able to support all of that.

So the distinction between qualities and properties is really what's on the problem domain side as seen by the users and what's on the solution domain side as seen by the implementers and operators.

So what is grid architecture? Grid architecture is, in part, the application of system architecture methods to the grid, but we have also brought in the relatively recent, and I mean starting back in the 2000s, general theory of networks and some elements from control engineering. We've put all those together and applied those to the grid so there's considerable knowledge about the grid involved in this, too, and that's what we mean by grid architecture.

So this is specifically not enterprise

IT architecture nor is what most people would have called over the last 10 or 15 years smart grid architecture. This is really about thinking about the entire system and I'm going to show you a little bit how we consider about that. Some of the paradigms we use are listed here and these are probably terms that mostly you haven't seen before in these discussions.

That's because most of the discussion has been from the enterprise IT world but we think of the grid not as a large collection of systems but as a network of interacting structures. And that's a point of view that arises from the paradigm of ultra-large scale systems that came out of work at the Software Engineering Institute at Carnegie Melon University where you think about certain systems being so large and complex that they're referred to as ultra-large scale systems and there are a set of characteristics that define those systems.

Turns out that our power grids fit very nicely into that paradigm and that tells us that we need to think about things a little bit differently than we would for ordinary large systems. So we use a variety of methods, some of which would be familiar, some of which might be less familiar and I'm going to show you some of the results we get from that.

Some of the principles that apply, though, are that the architecture really is there to meet the needs of the stakeholder and shouldn't violate some established principles. But it's not really there to just be complex for the sake of complexity. It's not there to be elegant in the eyes of the architects. You get a fair amount of that from some folks who do this kind of work.

It's not intended to be art. To the extent that we can manage, it's intended to be science. And that's hard because the scientific basis for architecture is not as fully fleshed out as we would like to see it. It is not as fully fleshed out as you would find in, say, physics or electrical engineering. But there are a lot of things that we can use and a lot of bases for this that give us very strong handles on significant pieces of it.

And ultimately it needs to be consumable by the stakeholders. I mentioned earlier on that part of the purpose of this is to help stakeholders think about the problem, help them manage the complexity, help them understand, help them see it from their point of view. So we look at this incredibly large, complex system and we have large numbers of stakeholders. They need to be able to look at a vision of the grid as it may emerge and see their interest and needs and constraints reflected in it.

So we have to be able to take what ends up being very complex and break it down in such ways that people can see the part that they're interested in. That process of breaking things down is a little bit complicated but we are able to do quite a lot of that and we are seeing some uptake of this now in the industry and I'll show you in a little bit.

So I mentioned we think of the grid as a network of structure. So what does that mean? Well, we have classified the structures in ordinary groups and the most obvious one is the electric infrastructure. Everybody would clearly see that. And then, there is also very clearly an industry structure. And of course, there's a lot of work going on now in the industry to think, rethink certain aspects of that industry structure.

Regulatory structure, naturally and digital infrastructure, so all of the information and communication technology stuff that we think about, we classify that as one of the structures that we have to think about in this network of structures.

Control structure where you think about explicitly. This is such an important function in the operation of our grids that rather than treat it like it's just another application as you would see in some approaches, we break that down very explicitly and think about that because it has strong structural implications.

And then, there are a variety of what we refer to as convergent networks. These are things that are starting to interact so closely with the grid that we have to think about them simultaneously with the grid and among those would be things like some of the fuel networks, transportation networks and even social networks.

So within each one of these structures there are a variety of pieces and ultimately you would see all the pieces of the grid in here. And we have just classified them in a way that helps organize them. But there's one that's actually not shown here yet that exists partially in the grid in some places. It's hidden in some places but it's in there and other places it doesn't exist at all. And we refer to that as a coordination framework.

You know, when I started to talk about this with the industry probably, oh, four years ago, people were kind of puzzled about it. But honestly, if you go to the conferences now you will hear an awful lot of discussion about this topic of coordination. And the reason it came to the fore is because when people started to think about connecting vast numbers of devices to the grid that would interact with the grid, in a significant way, but not to be owned by the utilities, then the question of how to get all of those to be cooperative and not fight each other so that we could solve a common problem in the delivery of energy led to the issue of thinking about this concept of coordination.

To be rigorous about that required some things that we wanted to delve into and, in fact, there is a body of knowledge that can apply to that and we have worked quite a bit on that. I first saw some of this, believe it or not, in a Chinese engineering paper in English, not in Chinese. I don't read Chinese.

And it pointed me to some work that had been done in the networking area. That's where we got interested in the work that was being done by people like John Doyle at Cal Tech and some others to be able to put a rigorous basis behind how to do this sort of thing because a lot of work in this area was very ad hoc. And when you put things together in an ad hoc way and you aren't careful about the structure, that's a fabulous recipe for getting unintended consequences.

So we were interested in putting them on a stronger footing and, in terms of coordination framework, we've made very good progress with that. I need to skip that slide because that's actually interactive and I can't do that. I don't have a mouse to push the buttons there.

One of the things that we do is look at industry structure, as I mentioned. This is an example from some of the work that we did last year for the Department of Energy. Carl Peckman had sponsored us to do a good bit of this work and he saw the value in using this as a means to help think about the problem.

You probably can't read the details of that diagram from there. If you can, your eyes are pretty great. But what we do is we break these things down. The issue here is to understand all of the various entities involved and how they relate to each other and break that down even further as we drill down into it. So we construct these models for the structure of the industry.

The structure of the industry is closely related to two other issues one of which is control structure and another which is coordination framework. So pretty important to do that. A lot of discussion has been going on in the industry around some concepts that are far from being settled but are pretty popular. The idea of distribution system operators and so on, so we constructed a model of what one of those arrangements might look like, an industry model.

And then, we took a look at extracting from that the coordination framework that underlies that. So we looked at the original arrangement and we were able to actually look at a structure like this and analyze some of its key properties and then, look at what it would be like under that DSO model and compare those properties to the original model. And that helps provide architectural understanding for and potentially justification for certain kinds of structural changes to the industry and to the control systems that would result from this.

People have found a lot of value in being able to think about this in this particular way. And so, we were helping some folks work their way through that.

We also took a look at things like whole system control structure and, boy, if you can read the details on this diagram you're really good. But let me blow up a part of that.

Understanding, for example, in the bulk system level how the markets and control systems interact in detail has become rather important because there are efforts underway to think about creating markets for distributing energy resources that might behave in somewhat similar ways at the distribution level.

And so, understanding that interaction and why it's important when you're thinking about markets and market rule is to also understand how it's connected to the control systems is of major importance. And so, providing models that help people understand and see those implications is a part of what we do with the grid architecture work.

We also, in the course of the work last year for DOE took a look at some of this convergence issue around different kinds of infrastructures. In particular, we were interested in the case of gas and electric this issue of midstream generation which some of you may be familiar with. In the case of shale gas, a lot of that gas is brought to midstream compressor plants and then to midstream processing plants before it's separated out and the natural gas goes into the main gas transportation pipeline.

But some smart folks figured out that they could put midstream generation at those midstream processing plants, so less than 20 megawatt size generators. They get the gas there sort of wholesale before it goes into the gas transmission system and they generate electricity connected to the transmission system but close to loads.

So it creates a sort of inner resilience loop inside a much larger loop involving gas and electricity. And that was the phenomena we were interesting in capturing in that particular work and illuminate it a little bit.

So what have we been doing lately with this? Well, we've had some interesting uptake. Some of this was done as part of the work for the QER, through EPSA last year, and that was of limited scope meaning we do not try to build an entire grid architecture and we're continuing to work forward with Office of Electricity. So there's a large document that we produced, 115 pages' worth of the kinds of things that I showed you there. Some of it is tutorial about the process and methods but some of it is actually looking at existing structures for our grids and then, selected forward-looking views of how the grid could evolve and using these methods to depict and understand them.

And some of this work has started to become pretty popular. We find it being referenced a lot in industries now because the paper has been passed around some. And for example, it's being used in the law class at GWU about the grid.

And the reason I point that one out is because remember what I said about this is intended to be consumable by all the stakeholders and be useful for more than just architects and engineers? Well, these are law students learning about the grid and the professor who teaches that class saw the paper and thought this would be a useful way to help them see things through kind of a different lens.

So I was kind of interested when I heard about that because when you get those unexpected results, that's sort of a good indicator that maybe things are going in the right direction. We've also been privileged to provide a little bit of assistance to the New York REV process and so, that's an ongoing thing where we're taking some of these methods and applying them there.

So some of the models that you've seen here, we're building the corresponding model specifically for the State of New York both in terms of existing and in some potential future views of how things may look because some of what they're concerned with in terms of roles and responsibilities at the distribution level and the creation of markets and so on, are greatly aided by having these multiple structural views to help them see the potential consequences.

And so, we showed them a little bit what we were doing and they said that looked like that's useful so we're working with them going forward. And some of the insights that have come out of this are confirmed in a variety of ways by what people thought they knew in the industry and what we were able to show is that our architectural view says the same thing. And one of them is something that we talked about recently is the Senate Committee hearing on -- there's a

Senate Committee on Energy and Natural Resources hearing on technological innovation in the grid.

One of the things we've talked about is the combination of storage, power, electronics and advanced controls becoming a new general purpose grid element as fundamental as transformers and circuit breakers. So one of our views is that, you know, 20, 25 years from now the engineers who are building our grids then will wonder how we ever got along without the capability for fast bilateral storage and power electronics.

So that gives you an idea of what we're talking about there in terms of grid architecture. It is the application of system architecture methods to the grid using rigorous bases where we can for the structural elements as opposed to being sort of artistic in composing them. We try to have underlying fundamental mathematics so that we can actually understand the properties of those structures, predict what they're going to be and understand the potential interactions and provide ways for people to think about all of this in a more powerful way than the traditional methods.

And that's why we take the view that the grid is a collection of interacting structures that helps us get at those things. I did not show you some diagrams that we created here but there are interaction diagrams that show how different changes, for example, the distribution level with penetration of DER can cause impact at the bulk system level.

So and the lesson there is that we have to be very careful about the way we reengineer the distribution level because we can create unintended consequences that go beyond just the local neighborhood level. So let me stop there and see if you have some questions.

CHAIRMAN COWART: Thanks very much. Questions? Let's start with Ake.

MR. ALMGREN: Yes, this is a question, all of this sounds very good. Is this available if I want to see and learn more? How would I do?

MR. TAFT: So the work that we did for DOE last year is available and I can provide that to you. The more general information on the methods and so on, we're getting to the point of putting together some documentation on how we do this. We haven't published a book or anything. We've actually thought about doing that.

What we've done is we've gathered up a lot of material from a variety of sources. And so, we have all of that and we've added to it and organized it so we're getting to the point where we're about ready to start teaching the methods to other folks, too, but we've been sort of engaged in applying them ourselves lately.

So I can't point you to a single text. If you'd like you can -- we can talk afterwards, send me an email and I will get you some of the key references for where we get the information and where we derive the basic methods from. Eventually, though, we're going to have to create some sort of a reference manual or even get to the point of writing a book about how this is all done because we're starting to accumulate enough knowledge about this to have that as something that we could actually do to be able to teach people. And we want to because we think there's a broad application for it.

MR. ALMGREN: That would be great. Thank you.

CHAIRMAN COWART: Paul?

MR. CENTORELLA: Thank you, Jack. This is excellent work. So I wonder if you could share with us a little bit more of your current thinking about the coordination framework, in particular as we think about the grid going forward, we can imagine some devices that are operating autonomously, responding to local frequency or voltage. We can think about some devices that are sort of semi-autonomous. They get some information from an operator but then figure out themselves how to respond to that and other things that are more like conventional notions of distributed control.

And that creates a whole set of complexities as you've identified and how those things work together, what kinds of information system operators can provide to those semi-autonomous devices and how you make sure they all don't fight one another. I'm curious what your current thinking is about all that.

MR. TAFT: Yeah, I was just going to back up to a slide here and point out a couple of things. So this is actually what I think is one of the largest problems that we face with grid modernization and why I said a few years ago people weren't thinking about coordination but all of a sudden it's on everybody's minds.

With the grid, it's especially complex just as you pointed out because we have such a mix of devices and systems and it's not just because we have legacy devices in systems. It's because we have the desire to have various kinds of operating modes for various devices.

And so, a lot of the mechanisms people tend to think about for how to operate all this stuff impose a pretty strict regime on those things and sort of give them only one way to be coordinated. That's a problem. And so, what we were looking for was how do you resolve that issue and some of the principles that came out of our thinking about that are on here.

We talk about things like objective and constrained fusion but local selfish optimization inside global coordination. To actually do that, we turned to some work that originally started to my knowledge almost back in the late 1960s when in the control engineering field people were thinking about both hierarchical and distributed control and how to keep a disparate set of elements focused on solving a common problem.

And they actually called that coordination, there were sort of two classes of ways they do that, they were called decomposition and structural decomposition. So I sort of knew about that from my studies in control engineering and had almost forgotten about it. The Chinese paper that I mentioned to you actually made me think about that again and when I started to read what they were talking about, I found it more recently in the 2000s, people were looking at how to be rigorous about network architectures and they had turned to similar methods.

So I started to investigate those methods that involved what's called layered decomposition and found that the potential exists there to be able to accommodate a variety of different criteria at each level of whatever structure you're trying to coordinate. So you can actually, in fact, formulate these things so that you have devices that are coordinated in different ways depending on their needs so that you can allow for their local constraints and their local optimization criteria and still have a minimum amount of highly scalable information that flows throughout that coordination framework.

So the mathematics is a little bit involved and if you want, I can share you with you some of the underlying papers that we drew upon to understand that. But it is one of the most crucial problems, I think, because if we go to the future that a lot of people envision where we have enormous numbers of devices that are going to interact with the grid. We have no choice but to find a mechanism to solve that problem equitably for everyone and that means doing things like boundary deference.

That's a term you rarely will hear in terms of these architectures but it means you have to have a mechanism that respects the boundaries of systems and organizations. If you do not, if you think you're going to just run roughshod over those boundaries you're going to find out that that's not going to happen, right?

So you have to be able to have a coordination mechanism that can always be partitioned in such a way that when there is a boundary to be observed is capable of doing that and that ends up creating an interface and therefore a specification for what information flows there. The trick is you don't want it be forced to be the same everywhere in that structure.

And that's the hard problem and we think we have a good handle on how to get there. And we've been doing some work with Steven Low at Cal Tech and Keshav and University of Waterloo and some other people about the basis for that and some work going on in our lab as well. So long answer to your question but really a key point.

MR. CENTORELLA: Great, and I look forward to seeing some of the papers.

CHAIRMAN COWART: Wanda?

MS. REDER: Yeah, really good work. I guess my question is kind of related to both of the other two prior ones in that, you know, how do we actually get this into practice? I'd like to talk a little bit about the distributed control architecture that's likely going to apply in the distribution side and how do we move that into industry? How do we kind of get those boundaries? What are the next steps?

I know there's books and teaching and all that that has to go with the tech transfer process but if you could expand on that, it would help.

MR. TAFT: So from my standpoint at the

lab our primary channel for doing that is the work that we're doing with the Office of Electricity directly in terms of expanding the basis for this type of architecture work and applying it as it needs to be. And also, you're probably aware that there is a proposal for a pretty large program called grid modernization effort. It's a multi-lab initiative.

There is a significant element in that proposal, in that work to do this kind of thing and both expand the architecture work and apply it as well. So that's sort of the mechanism that we see is how to move this forward significantly. It's largely through the efforts of DOE and the Office of Electricity in particular and then, the grid lab initiative, I mean, the grid modernization initiative over the next roughly five years.

CHAIRMAN COWART: I'm just going to come around the table this way. Anjan?

MR. BOSE: Jeff, you know I'm still left a little wondering as to what things we can do with this model or whatever you call it, whatever you're producing. I mean, can I if I was a bench engineer in a power company, can I use this for something? Design my distribution system for example? Or you know, all models, you talked about models and you talked about engineering and I'm left a little puzzled as to which parts you can do and which parts you can't.

MR. TAFT: Oh, so a little bit of empirical data around that, one of the earlier versions of this work is a paper that is about ultra-large scale control architectures for the grid and we have done that work before I came to the lab. Since then, that's become a part of the work that we do at the lab.

We've had folks from the industry come and tell us that they use that as a template for some of the work they've been doing at places like PG&E for example. So we know that people have applied these models to think about their overall architectures and structures going forward. And that's one of the purposes to look at that and say, okay, what does this tell me about how I should be building my systems and interfaces?

Elsewhere, we're doing work with the New York REV process and there we're helping them look at the implications of the kinds of structures they're considering and the way they're considering restructuring their distribution systems and their markets and understanding the interactions with their control systems there.

So in that case, it's a matter of helping them manage the complexity and understand the implications of what they may choose to do and then help them build some models for how it's going to look so that those can be analyzed in more detail. So there are multiple purposes for doing that and that's one of the things I was talking about early on is that it helps you understand the interactions and complexities.

It helps you think about how you want to structure things going forward. It helps you understand what constraints you need to remove possibly and ultimately it will help you design these control systems, especially coordination frameworks for them. So in the work that we're talking about for the grid modernization, the control architecture, excuse me, the control engineering aspects of that work are closely tied to the architectural aspects. And what we expect to do is develop actual control system designs out of that that use these architectural principles and then are validated through traditional methods of simulation and test and so on.

So this is sort of looking at the overall structure of the system in the large and being concerned about when we do things with controls, how does that interact with the industry structure. How does that interact with ICT? What are the implications for regulatory?

It's that large picture and overall shape of the grid that we're mostly getting at and the control framework part of it is specifically aimed at, I mean, sorry, the coordination framework part is specifically aimed at helping the engineering of the distributed control systems going forward.

CHAIRMAN COWART: Tim?

MR. TAFT: Finally.

MR. MOUNT: So this is -- yeah, finally. So this is very interesting stuff but my question is related to Anjan's and that is can you compare the sort of pluses and minuses of different systems? And I'm thinking of, and I hesitate to this as a New Yorker, I mean, has Texas got it right? You know, should we have small systems with weak interties as opposed to having the current sort of AC grid in the east run by lots of different people with very sort of peculiar rules about interties?

And would we be better off having a system where we have a lot of semi-self-sufficient micro grids that really can cut off from the big grid if it misbehaves?

MR. TAFT: So a part of the purpose of this work is to help give us ways to think about those problems and make those comparisons. And I didn't talk about it much here but an aspect of this work is actually to be able to be quantitative about these architectures and to say we have a lot of competing views about how things should look. And how can we actually measure how different or similar, how can we measure how well they meet the intentions of the people who need to use them?

Most architectures make that very difficult to do at an abstract level. So you have to get down all the way to specific designs and then do simulations or whatever on those designs and say, well, I can compare this design to that one. But if you're -- before you get to the point of committing to all that work to create designs, you'd like to be able to do that at a structural level. And so, some of the work that we're doing here is aimed at being able to formulate these things in a way that's rigorous so that you can say, all right, this arrangement with multiple neighboring micro grids works in these ways and has these limitations and these properties and this more hierarchical structure.

Has these and actually be able to compare them and get numerical results out of them. So being able to do that involves some things that are mentioned here, graph theory and matrix methods and so on that are not typically applied at the architectural level.

That's part of the more theoretical underpinnings that we've been working on so that we can actually sit down and say this architecture has for these reasons better properties than that one. And I will tell you that one of the things that I like to confound my architecture peers with is something that we now know how to do which is to say I can calculate the angle between two architectures.

But that means that we confirm it mathematically and we know how to see how well-aligned they are. And we actually can calculate an angle value at a high dimensional space. That's the only way we're going to get at these at a high level otherwise we're always forced to go down to specific design instances and then, do the simulations, compare them there and that leads you to just an unbelievable number of options that you have to consider and that's been the problem, right?

So we're trying to make this -- handle this at a more abstract level so we can handle classes of problems and say, okay, we know this direction is relatively better than that direction. And we're making good progress with that I think.

CHAIRMAN COWART: Chris?

MR. SHELTON: I applaud the work. I think this type of work is some of the best work that we see at DOE. And I had several questions about the level of principle design that came out, I think, in a lot of your answers. But I do have a question about how much the current context that you represented in your slides, and maybe it's just the way the slides got put together, is a binding constraint?

And versus coming at it from a principle design of the overall problem set of delivering electricity in a ubiquitous fashion. Can you -- I'm sure that's something that you're having to deal with. It would be nice to hear about how you're dealing with that.

MR. TAFT: Yeah, you know, in the U.S. we have this situation that we have an enormous legacy, right? And utilities don't have the luxury of just shutting everything off for a good while and tearing it all down and building it back up again. And everybody's heard the standard analogy about it's like an airplane in flight and we're going to rebuild it and we're not allowed to land and all that.

So understanding existing structure is important because we have to make a transition from that to whatever we want it to be. If we were in a frontier nation, we could say, you know what? Let's just start from a blank sheet of paper and from rigorous principles and derive something that we think is right. Here we have the more complex problem of transition.

And so, we have to think about the

existing structures and a lot of the work that we did last year was in documenting existing structure and that was the request we had from DOE. What does it look like now in the way that you represent it? And what will it look like in certain views going forward?

And then, once you do that, you know, there's the old joke about navigation, the two most important things are to know where you are and where you want to go? It's hard to develop transition plans if you don't have those two things figured out.

So we have to think about the current structures and so, some of the stuff that we did is, in fact, that and some of the things I showed you are that. In the work that we did, we have some future views and I haven't shown much of that here because they were selected future views not the whole grid.

The work that we'd like to do going forward gets at the whole grid and the future views have to be multiple views because there's not just one way to get there and given the diversity of our utility industry, there's not just one way that it's going to happen anyways.

So that makes the problem interesting to manage in the sense of multiple views of the future but they all have to take into account where we're starting from because otherwise we can't get those transitions done. So that's why we look at both and it's a complex problem to figure out what constraints do we have now that are really significant that we need to change because you'd like to have the minimum number of changes necessary to open up the future, right?

So rather than saying well, let's tear it all down and start over, we say well, okay, but if we understand structurally where the limitations are maybe we can just disconnect a couple of the dots and reconnect them and open things up and that's part of the challenge of this kind of work is to understand that. So that's why we have to look at the current as well as the future.

CHAIRMAN COWART: David?

MR. MEYER: Jeff, I want to go back to markets in relation to the architectural approach. Markets are where we've encountered many unintended consequences and I've listened to various people and just to see how they're reacting to some of the kind of material you're presenting. And some of them on the market side seem skeptical about can you really bridge from where you start into some of the challenges of market design?

And so, I want you to elaborate a little on your thinking about how we deal with the interface here between physical structure and more market-oriented questions.

MR. TAFT: So some of the work that we have done has been to show how existing organized wholesale markets and bulk system controls actually work together. It's quite remarkable how they do, in fact. There are variations in different places of California; ISO model is a little bit different than the New York model.

It turns out that there are a small number of people who actually know how that works and a much larger group of people who actually don't know how that works. And it's been interesting in doing this work for me to talk to market economists and ask them do you understand how your market mechanisms influence the controls? And ask the controls people do you understand -- because I will ask the controls people are these markets inside or outside of your control loops?

And a lot of times they don't know. There are some people who know but not very many. So when you start to think about that, those kinds of things need to be illuminated and after a while when I talked to some of the market folks, they start to go, okay, I didn't actually really appreciate that and they begin to see the value. But it takes a while first because traditionally market design hasn't thought about that.

And you know of the history of California ISO, the first time they put the markets together they didn't think much about that and they ended up with all kind of congestion problems and that's what led to the development of locational marginal pricing. That was bringing the physical system back into the arrangement.

But it's more intimate than that. These markets, the 5 and 15-minute markets are actually inside the control loops for secondary control for the generators and tertiary control. So there are dynamics issues there that have been worked out pretty well at the bulk system level but at the distribution level, if we create new markets, there's the possibility that the dynamics are going to be considerably faster and that we won't have the type of system inertia which stabilizes our systems at the bulk system level.

So those are terms that the markets folks aren't used to hearing, system inertia and stabilization and stuff like that. When they start to understand why that matters, then they begin to realize that maybe they're going to need to have some partners from the control side.

When the control system folks begin to

realize that those markets might actually have an influence on system stability they get very interested in what's going on. And that's the beginning of that conversation and then, the question is how can we each understand what's going on here? And that's part of the purpose of this work.

So it's been traditional that those have been two separate communities and only a small number of people who are responsible at some level with putting this together have actually seen how it goes together. But we need much wider views of that because we're about to try this on a much wider scale at the distribution level than in a handful of markets at the bulk system level.

It's a pretty important issue to understand. We could create some awful problems if we aren't careful here. By the way, we made that point with the New York REV people and the first time I presented to them we talked about that.

And I started them in more detail some

of the things I've shown you here especially about markets and controls and for a lot of them that was kind of an eye- opener. And so, they started thinking about that and began to realize that actually there are maybe some considerations that they need for that, too. And some of that's going to require some analytical work as they start to formulate how they really want it to be, there'll be a need for some analytical work to ensure that those things are going to function in a way that they expect so that we don't have another oops, we should have had a locational marginal pricing situation develop.

CHAIRMAN COWART: And since we need to move on, Carl, I think you're the last question.

MR. ZICHELLA: Well, luckily, Jeff, you answered most of my question in your last two answers for Chris and David. But I'm also and I'd look at what you've been talking about, ultra-complex systems, it seems like some of the solution to where we need to be headed is to have systems that are not unnecessarily complex.

And to reduce complexity when necessary and this goes into the markets question, too, because when you have 38 different balancing area authorities in the Western interconnection all controlling part of the grid and you don't have an organized market that's -- and they're all functioning bilaterally, that's an unnecessary complication that helps, that actually hinders rather, that transition that we're seeing.

That is happening in real time. So I don't know if that requires a response or not but it certainly struck me when I was listening to you that what we've intuitively thought for a long time, when you start to lay it out in an architectural sense, it really starts to leap out at you.

MR. TAFT: Yeah, what I was looking for here, the second principle here, essential functionality drives complexity not architectural elegance. The issue here is we don't want to make it any more complicated than it has to be to do the job. There are times when people get carried away with that and more often, though, because our systems are so large and diverse and involve so many different entities and stakeholders, I think some of that complexity has, in a sense, accidentally evolved because of sort of silo development and so on and people saying, well, I'm going to deal with the constraints as I see them instead of saying maybe we take a systematic approach to this and make a few changes across here and there and get all (inaudible).

So having these large-scale views is important because we're getting to the point where that kind of incremental approach is just becoming more and more difficult. And you pointed to a key example of that. Looking at this in the whole and looking at the overall structure and saying, now, where could we relieve some constraints here with minor structure changes is a key issue for this kind of work.

MR. ZICHELLA: Yeah, it's like we've designed the western grid like a house that we just kept adding rooms to. We're not sure if there's much of a flow between them but they're all there and everybody's who's helped build those rooms are very attached to them.

MR. TAFT: So I have a different presentation that talks about architecture in the sense of first of all, where do you start first if you're going to build a house? Do you pick up a shovel or a pencil first? And my dad told me when I was a kid talking about these and I know some guys that try to hang the windows first.

But later in the presentation it says, with good architecture we get things like the Taj Mahal and various famous buildings. With the incremental approach, we get the Winchester mystery house which if you've ever seen that thing, it was built by an eccentric person and just has staircases to nowhere and all kinds of peculiarities.

It's a museum now but that's what can happen. And to some extent because our systems grew organically with so many different parties, we have some of that kind of legacy in there and this is a good opportunity with grid modernization to think about those issues and say, where can we make those changes that are minimal but would really relieve these constraints and make this all work better?

And reducing the complexity is always a good thing. One of the things that we've been doing in the architecture work is complexity measure so that we could actually get a handle on that early on, the idea being to do exactly that minimize the complexity.

CHAIRMAN COWART: All right, thank you very much. Appreciate it. Wanda, I think you're next.

MS. REDER: Okay, the next thing on the agenda is the smart grid subcommittee report out. So we've got three major pieces that we're going to talk about today. The first one is Clark and we've all been working on the R&D paper and we need an action from the committee for approval. So oh, David Till, what's that?

Anyway, Clark, go ahead. Clark's got

some slides on this. I know that many of you participate in a survey certainly have looked over this paper so he's going to go through that and then, Carlos is going to follow up with the distributed energy storage work that's been a joint piece between the storage group and smart grid and I'll follow up after that with ARE comments. Clark?

MR. GELLINGS: Thank you, Wanda. About almost four years ago, a group of us in the smart grid subcommittee decided it might be a good idea to at least elucidate what we think are some of the R&D needs surrounding technology.

Why did we do this? It wasn't because we thought our friends at DOE didn't understand what the technology needs are. They certainly understand them very well. But everything we do at the EAC is in the public record and we were a little concerned that the predominance of what was being discussed related more to smart meters than it did to really the overall functionality that we all envision in some way, shape or form might be part of the power system of the future.

So we started with a paper, like I said, just about four years. And remember that in this process the members of the committee changed several times. The members of EAC changed as well. So we identified first the other sort of intelligent electronic devices that, you know, the digital stuff that would be more related to smart grid than the physical hardware that might also, of course, be part of a modernized power system.

But as the committee membership changed and more and more people contributed, the paper grew. And it grew to the document that you've received in your email which is rather substantive. And actually, by its growth, it forced us to move a bit away from any specific recommendation. So what we really have more than anything is a nice catalogue of what some of the technologies are that one might consider as part of a modernized power delivery system.

Now, given that, we wanted still to -- desperately to give at least some advice to DOE about whether we see anything in that portfolio that we think ought to come to their attention. So what we did is we conducted a survey that almost every one on EAC participated in and you have all the results of that survey but I'm just going to quickly mention a few. I'm not going to show you all the charts. You have them. I hope you can read those.

So we asked you a number of questions and asked you to rate a few things from low to high with number one being highest. And we show you here the mean and the standard deviation as well. And first, we suggested that if were, as we considered in the paper, five areas of technology that DOE might work in, being transmission substations, distribution, things beyond the customer's meter, customer assistance if you like, we can find other labels for this, cyber security since that came up so often in our discussions, and various communications technologies and I know, we all know, overlap and so on and you really have to look at the text to see what we intended when we identified these.

And we asked which is the highest priority? And I just thought I'd quickly share with you some of the results. And these are not definitive and we're not turning back to DOE and saying, you know, well, here obviously this is a conclusion because it can't be an obvious conclusion with this kind of deviation in the response. But there's some interesting data here.

You rated distribution as the highest given these categories. We also asked you regarding the importance of DOE being active over a range of technology readiness levels, I didn't define TRLs here but I intended it in the context of the NASA definition of TRLs. I grouped those into four which, by the way, we've done in some national academy work elsewhere so it's a legitimate grouping but one being research and discovery. The second being innovation and development, the third being demonstration and the fourth being commercialization and ultimately diffusion.

And I think we roughly know what those mean although, obviously, again, we probably could have some debate about the difference between a few of those categories as you move from one to the other. But the thinking basically is that a technology, something new and shiny, moves from the lab and somebody does something with it that formulates it in a way that it can be applied, demonstrated and then, ultimately, the hope is if it's useful to be somehow put in the marketplace and adopted and used.

And in this case it was, you might think interesting despite all of our talk about demonstration and commercialization that we think, collectively, we think the focus for DOE should still be more on the front end. We hear a lot of dialogue about that of course.

Then how much money of the budget would you associate with each of those categories? And pretty much, I think that one conclusion from this is that perhaps DOE shouldn't spend very much of their money on the commercialization and diffusion even though that, as we've already heard in the discussions yesterday, is certainly a problem area for us in terms of getting any of these technologies realized.

Then we asked a number of questions about which applications should receive the highest priority and I'm not going to show you all these charts. I'll just show you this one which was relative specifically to the smart grid and there's some indication here that you could say a little bit of a consensus around distribution automation as being the highest priority.

Some of the others that were mentioned were PMUs and you have to look at the definition here. It isn't the PMU itself but it's the applications of the PMU data more than anything. Obviously, electric energy storage. I've already said distribution automation but it came up again.

Next generation integration referring here to solving this very problem of how, in fact, do we get to an integrated grid. We've got these resources that are central. They're not going away. Certain central resources are increasing. What do we do with the increase in distributed resources?

Is the optimal for society some other architecture? Jeff, if you don't mind? And then, finally, PV inverters and here it was intended, I believe that these are, if you will, advanced PV inverters. The recommendation that came out of this, this is the only specific recommendation in that document is that DOE convene interactive sessions involving all stakeholders.

They do this already, all right? And so, this is a nudge, a suggestion that gee, you should convene sessions involving all the stakeholders relative to these technologies and it probably would be grouped by technology area. And use that as a forum to discuss options, paths and potential collaborative programs that DOE might engage in. DOE cannot do all of the things that we outlined in this paper even though we might like them to, the budget would have to be enormously larger than it is now.

Maybe perhaps some of the verbiage in here would be useful. We did try to address some questions in this document such as why should DOE do it? Why shouldn't the industry do it? And you'll see some paragraphs in there that relate to this.

So I don't know, Rich, the best way to handle this. So what we're asking, this turns itself into a memo from us to DOE if you approve it. So I'm going to ask for you to approve this but, Rich, do you want to have some discussion first?

CHAIRMAN COWART: Well, let's first -- well, in fact, I'm going to construe you've just made a motion.

MR. ZICHELLA: Second.

MR. GELLINGS: I just made a motion.

CHAIRMAN COWART: Is there a second?

MR. ZICHELLA: Second.

CHAIRMAN COWART: All right, could we have that recorded? I just -- all right, now, let's have discussion on the motion. Are there comments, questions people have about the document? All right, I hear no discussion.

I think quite a number of members of the committee have had the opportunity to be involved in preparing it, looking at it over the years. It's been under discussion and I would like to add, by the way, my congratulations to the drafters for, and particularly to you, Clark, for bringing this home and it actually does exactly what you said. It's a long memo from us to DOE supporting the DOE R&D efforts and explaining why quite a number of them are not likely to be performed by other institutions and therefore, why this is an important endeavor for the good of the country and I want to thank you for it.

MR. GELLINGS: I appreciate that.

CHAIRMAN COWART: Yes, Wanda?

MS. REDER: The only other thing I would add, I mean, it was a tremendous amount of work and I think it's a really good piece of work but the interesting thing to me, on top of it, was kind of the perspective that the survey added. I thought it was a really neat way to kind of extract our collective thinking on prioritizations. So that might be a tool for other things going forward.

CHAIRMAN COWART: Good point. Are you ready for a vote? Anjan?

MR. BOSE: Just a question. You presented the survey, Clark, but the report actually, the recommendations in the report is more than that.

MR. GELLINGS: That's true.

MR. BOSE: You got a full plate of --

MR. GELLINGS: I tried to cut to the chase with these few words here. In essence is the action that we're suggesting on DOE's behalf. The suggestions are much broader. The suggestions include words like expand, enhance, develop and so on, yes.

MR. BOSE: So what I was going to raise was, I mean, I read this one and I fully agree with everything in it. We've worked on it together but I'm wondering how this fits into what we heard yesterday with all the things in QER and QTR and the presentation from the labs. And I mean, even if we pass it and I think we ought to, this recommendation, we need to kind of reconcile or help reconcile, the EAC should help reconcile some of the things that have gone on other than this process.

MR. GELLINGS: That's for me to answer? All right. And actually it's embodied in the first bullet there which is to suggest, we have a significant diversity among the EAC members. But by no means significant enough of, for instance, if we want to talk about, oh, I don't know. Let's take FACTS. You've got three or four people around the table who understand, really understand FACTS and what the technology is, what the details of a FACTS control system, a cooling system and so on.

All of the problems that we've had with Inez or Marcy or any of the other FACTS installations, the EAC, as a group, would have difficulty in driving down to that level of detail. So we really have to break the problem of exactly what you do, which options for development, how you pursue development, we have to break that into pieces.

And so, the best way we thought is to get the relevant stakeholders for groups of technology together. And that's essentially that recommendation.

MS. HOFFMAN: Anjan, in response to your comment, I think internally to the building, we are trying to figure out we have to do some coordination and alignment with respect to where the grid modernization lab consortium is heading. And there are five topics or six topics in priorities there. So we're actively working that issue.

I don't think that should slow any sort of efforts because we're going to be going through that process anyways and there's a lot of discussion internal to the organization of how do we work that translation. So I think we'll get there. The important thing is just to get some of those priorities on the table.

CHAIRMAN COWART: Any further discussion? I take it we're ready to vote. All those in favor of approving the report, please say, aye.

ALL: Aye.

CHAIRMAN COWART: Are there any opposed? All right, it's adopted unanimously. Thank you very much, Clark, and the subcommittee as a whole.

(Motion passed and memo adopted unanimously.)

MS. REDER: Carlos is going to present the distributed energy storage work.

MR. COE: Well, good morning. So a series of us from the smart grid subcommittee and the storage subcommittee have taken sort of an interesting task. And that's to look at distributed energy storage. And the first part of this process is to define what we mean by distributed energy storage.

And we've defined that as anything that's at the substation or south of the substation and even behind the meter. And then, we recognize that this effort also interacts in the DER space. So this is a very interesting dynamic, part of this business and one thing, I'm sorry, I didn't realize I was the slide holder here.

But then we'd also conclude things like thermal energy storage potentially as well as micro grids. And when we look at the scope of the white paper, the scope is intended to look at an all-inclusive aspect of this including markets, regulatory, interconnect, the status of technology and applications in this area, benefits, the market benefits or the value of this category.

We've also, through this discussion, added a section on codes and standards. That's another area that we thought would add to this white paper. And then, we've decided to also add appendixes to this, a DER appendix which would look at not just DER but also EB applications in this space. And the purpose and goal of the white paper is to basically identify gaps and recommendations to DOE of areas that we think DOE could participate in.

And when you look at the DES space, a good way to look at this is, for example, look at a project list and this map shows the existing project list and this map dates back to second, third quarter of last year. If I updated this chart to today, you would see that this map would be more highly populated with projects. So this market is changing rapidly.

In fact, when we were talking about writing this white paper, we're trying to take a snapshot of a motion picture that's in process. And from the time that we've started this process to today, the market has changed rapidly. And, in fact, actually if you've seen market projections in this space, it has shown that this market is expected to, in essence, explode over the next 5-10 years.

In putting together the white paper, we decided to not just leverage our own experience, our own committee's experience of this but we also decided to basically do expert interviews. And, in fact, I'm going to suggest that this might be like Clark's survey process. I was going to suggest that this might be an effective way to capture the essence of what we're looking for. And these expert interviews we were, I'll call it this was an open interview format and in the interview format we covered a series of I'll call it set questions but we also allowed the experts to freely discuss the market as they saw it, market and technology.

And if you look at the list, we spin all the way from market participants, actually people that are involved in the DES market to those that are utility space all the way to the ISOs and so forth. And from this group of experts, we got an interesting set of information. And I would like to just qualify what we're talking about up here that this is the observation recommendations from the expert interviews.

This does not include the inputs from the other committee members. But some of the recommendations, observations they made included that the market, as we talked about, is developing very rapidly. In the next few years this market is going to double and triple in size. What's missing in this space that places where DOE could participate is in development of market models.

So if you look at market models, market models are limited even in the bulk side of this. If you look at the distribution side of the market, that's completely a new space. So new market models, new market mechanics are needed.

Also physical models, one of the great things that I think in -- looking -- what I heard from Jeff was the idea of being able to look at this system space multi- dimensionally which is, I think, a key aspect of what's needed. But those models need to extend all the way down into the distribution system.

And that includes how do you control these things? So, for example, do we look at central control to local control? I think the other terminology I liked that Jeff mentioned was coordinated control but also the development of codes and standards that are addressing this area.

And that includes codes and standards that are set on I'll call it the risk that these devices may entail. And I'll give an example. Like, for example, if you look at behind the meter applications of DES, the codes and standards for those devices would look very, very differently than, for example, the standards that would occur if you were at the substation level.

The other piece that came out of it was the development of interconnect standards that provide, I'll call it, open access for these devices. Excuse me. And a common terminology that we heard was the idea of a plug-and- play for behind the meter applications.

Now, obviously, that's an interesting concept but I do think that when you look at interconnection standards, particularly behind the meter, they should fit into the category of almost like IEEE or UL kind of standards. And this white paper will also include or suggestions that came out of this study or the interviews were micro grid development and advancement. That terminology came up over and over in the discussions with the experts.

So when you look at our work plan, our work plan is that we've pretty much completed the expert interviews. We have a few more to do to fill in a few gaps. We've began drafting the sections of the white paper. We're also in the process of developing the gap analysis and the draft recommendations for DOE.

And the goal of this is complete a draft by the June meeting and a final version of this hopefully by the September meeting.

CHAIRMAN COWART: Thank you. Questions, comments on how this is going? I have one question concerning sort of the scope of the paper. I know there was conversation about whether thermal storage or one-way EV charging should be part of it or whether or not. And it sounds like you're sort of in the middle where you at least define thermal storage as a form of storage, energy storage.

But you didn't include that topic in your detailed analysis and the expert interviews. Is that where it stands?

MR. COE: Yes, our original scope was to look at electrical power in, electrical power out. That was our original scope. As we looked at that scope, we identified that we need to look at how these devices play in the DER space. So we added, I'll call it, a DER appendix and then, that appendix would include other DER devices like thermal storage.

When we looked at electric vehicles topic, it was interesting. Remember these interviews were free-format interviews. So the experts were allowed to bring up any of these topics that they wanted. What was interesting in the discussions, very, very few people, almost no one brought up electric vehicles which was quite surprising.

I think as we look at adding to the expert interviews, we'll add a few more DER experts to that list and then, we'll add at least one expert on the EV interconnection aspect. And those interviews should take place between now and June.

But I think looking at those appendixes to the main white paper just allows us to maybe build a basis for maybe some future work both in the DER space as well as integration of electric vehicles.

CHAIRMAN COWART: Yes, it seems as though the selection of the experts to be interviewed would have great bearing on the kind of topics that they naturally bring up. And I appreciate the answer. Any other comments or questions? Pat?

MS. HOFFMAN: One of the things that I've been hearing is that at least from the storage community is, and it goes under the applications, is the use cases and how to get some standardization and look at the system integration issues. Because it's not necessarily the device itself, it's all the work around how you integrate that into an application. And if there was a way to reduce the one-off kind of every site has to be analyzed and over analy -- you know, individually recognizing that there is going to be that.

That's going to occur anyways but if there's a way to focus that a little bit, I think that's probably going to be another aspect of this that is going to either bring storage forward or it's going to keep it in a very limited application.

MR. COE: I think the section that we envision to address this in the codes and standards piece of this and addressing the interconnect requirements. And the goal of it would be to develop a standard set of interconnect requirements that would fit all regions of the country. And then, that way just like you have UL standards for appliances, you would basically treat this as an appliance in a sense that certainly behind the meter.

The same level of care could be done for things between the substation and ahead of the, I'll call it, ahead of the meter, you know, applications. And some of that work has already been done. Some of that work has been done by DOE, people like KEMA, EPRI. So there's a good basis of work for the interconnect standards at the, say, the substation level. But that kind of work has not been done sort of behind the meter.

And so, that would be one of the recommendations that would come out of this that those same kind of modeling and testing and all then develop a standard spec for behind the meter, it would be one of the, I would say, would be one of the recommendations that come out of this.

CHAIRMAN COWART: Thanks very much.

MS. REDER: I'll give you a few comments on the ARRA piece now. Okay, as you're probably well aware, we're in the fifth year of the ARRA effort which included about $9 billion on 131 projects. So the intent of this piece of work is to give the EAC's reflection of that.

The intention is to get it done and provide it back to DOE before their final paper is submitted or final synopsis of this work. So the deliverable has to be in the early fall.

Essentially what we want to do is cover the things like the background technology lessons, advantages, successes certainly of which there are many. It's not intended to really overlap and duplicate but just give a kind of a high level on our reflections.

Some of the early ideas is we know that it expedited some of the technology adoption. We learned a lot in terms of organizational development and skills and kind of advancing grid modernization, building up standards around this effort. Not that it's done but it's certainly expedited the process and we want to make sure that we acknowledge that.

I think, though, what we really want to do beyond kind of putting a stamp on where we are today is say okay, so now what? How can we further leverage this? Where do we go from here? And I actually see more of the writing along these lines than it is kind of in the rearview mirror.

In the chunks of areas where we're leaning towards writing around is the capability or capacity building, technology, performance, business case, system integration, standards, development and then, maybe some high-level recommendations. So the items that are coming forward now, and again, this is pretty early discussion but it gives you a flavor of the kinds of things we've been talking about.

On the capacity building or being nimble, being dynamic, making sure that the marketplace is viable in that respect. We know that the planning analysis and operational tools are in need. We've talked quite a bit about that as is the communication capability continues to evolve and electronics capability.

I don't think any of this is really new. We've continued to talk about these themes for quite a while but the idea is to get it in one place. If we could reference work that we've already done, so be it.

On the business case development,

there's still work to be done there across a lot of fronts. I think we've learned a lot. This information can kind of build into further work but certainly there is frameworks that are needed to kind of link investment decisions with society objectives.

I think Paul's paper brought that out pretty clearly and we might just reference that along with metric advancement, market development and such. Systems integration, back to Pat's point earlier, you know, a lot of this was kind of developed around technology silos and we think the next iteration is really going to look at it much more holistically so that would be a next logical step.

Also we know that the consumer aspect kind of needs to be brought in and more seamlessly integrated with the grid aspect. So there's still gaps that reside there that need some ongoing attention. Micro grid standards, planning tools, testing methodologies and then, of course these islands of technology which I just referenced.

Standards and policies, we've made some good progress but there's a lot more that's left to be done and that kind of wraps us up then with some recommendations. Right now, we're looking at recommendations along the lines of demonstrating the advanced integration elements so that it's more holistic than just kind of pockets of technology.

We've talked about these tools and really kind of needing to take it to the next step to enable both the planning and the operations pieces especially in a federated system that includes distributed architecture. I think Bob Curry actually brought up the metrics piece yesterday.

We know that there's metrics and methods around analysis that can continue to be refined and developed to actually get us all on the same understanding for success, common language. Another piece is how we do actually transition this technology as it goes through the different phases? And the labs are up here but I think it's a broader discussion than that.

And actually, it was highlighted pretty well yesterday in some of the discussions that we had early. And the last one, of course, is connecting this work with the grid modernization part. It's not like, okay, we're putting a bow on that it's gone and now we're on to the next.

It really is an evolutionary process and we need to leverage the findings lessons and that kind of thing. So that's what we see and in terms of kind of the sequence of events, we have a panel as soon as we wrap up with break here which the intention is to not only learn what they did but also try and understand where they're going with these lessons and technology. And that will feed into the paper.

We need people to help draft so we'll be circulating a piece of paper to try and recruit some additional help here. But after this panel and some inputs we're going to get quickly working on further drafting and aim to have the recommendations in the July/August timeframe so that we can get it submitted in a timeframe that's meaningful.

Any questions or input? Okay, then, thanks.

MR. MORRIS: Thanks, Wanda.

CHAIRMAN COWART: All right, we're back on time. Off by just five minutes. I'd like to take about a 10- minute break. We're through with the smart committee report? All right.

(Recess.)

CHAIRMAN COWART: All right, we need to get going again. If committee members would please take their seats? Just please take your seats. We're ready to go.

MS. REDER: Okay, as I mentioned earlier this panel is a springboard for our paper and Hank Kenchington is going to be the moderator. So I'll just turn it over to Hank.

MR. KENCHINGTON: So I guess we'll just have our panelists come on up. Craig? Yeah, I was going to say some name tags there. Good morning, good morning all. Good morning.

Yeah, yeah, let's wake up. Okay. Let's get things rolling here. Okay. So this morning we want to talk about the smart grid and what was accomplished under the Recovery Act going back as Wanda was saying about five years now. We've got some great panelists, boots-on, hands-on experience here.

We want to talk about what's been accomplished, what are some of the challenges and mainly, we want to talk about some of the lessons learned and how do we leverage these investments going forward? So to get it kicked off, I want to start with just maybe a little background. Take you back five years.

This is going to be a painful journey. These are some charts here and we look back at 2009. Top left is the industrial production and relative to 2007 on the left was 100, and 2009, March of 2009 when the Recovery Act was signed into law which was about 140, excuse me, $840 billion of that $4.5 billion was designated for smart grid investments.

But you can see the low point. It was right at the low point there in the industrial production, the monthly employment net gain and loss, big steep drop there. And I added the DOW Jones industrial curve which is again amplifies the situation.

So things were not in a very good state. And looking from where we were to where we are now reminds me of personal experience when I was working on my yard one time, a lady came by and said it's not the heights to which you have arisen, it's the depths from which you have come that are so impressive. So I think we've come a long way.

But so just to frame the issue just a little bit more, we had $4.5 billion, 3.4 billion went to the direct deployment of technologies and smart grid investments. 620 million to a demonstration program and then, realizing that the grid modernization is more than just technology. There's also planning and other policies that need to be addressed to effectively move the process forward.

We provided the funds for a workforce training, over $100 million for that. Some transmission planning, we probably had actually 12 million. This says, yeah, it's 12 million to NIST to start up interoperability work which is ongoing today. That panel has actually been now been privatized and provided assistance to states and also for energy assurance planning.

Our strategy from the beginning, we realized $4.5 billion while it sounds like a lot of money it's really just kind of a drop in the bucket when we talk about infrastructure spending. What we wanted to do is find a way to deploy these technologies in a way that we could continue and develop kind of a virtuous process where we could encourage to have ongoing grid modernization. So we want to deploy the technologies, measure the benefits so we can help build the business case. That would help inform folks like state and public utility commissioners and other utilities who want to make these kinds of investments. Who would then go forward with and continue to modernize the system.

And that was our strategy. The projects, as you see, are all across the U.S. These are just the smart grid investment grant projects which was 99 projects. But there were subprojects under those. So for a total of 228 utilities that were involved.

Today, where are we today? This is January 12th. We're fairly complete in the deployment of the technologies. I think, well, over 96 of 99 projects are more than 70 percent complete. So we're pretty much done there. But we're still collecting data. We're still analysis trying to figure out what all of this means.

And part of this panel helped with that, too. This is a chart that shows tried to a way to measure progress. This is the 3.4 billion in federal funding plus the cost-share which was more, which was over that. Our number is actually about $8 billion. The blue bars represent what's been reported as -- this go back to September 30th so this is a little bit old.

And the red chart shows our estimated, what we'll spend at completion. From a build, we call build metrics. Our original goal was 15.5 million smart meters. We exceeded that number. We're at 16.3 now. On the customer systems side you can see there, those include programmable thermostats, in home displays. On the distribution and automation side, we estimate about 8,900. We're at 8,939 switches. We've exceeded the goal there.

And on the transmission side, a number we're using there is the number of PMUs. When we started there was 150 or so PMUs networked across the U.S. We expected to deploy about 800. We're now at 1,360. We've actually deployed substantially more than the original estimates.

I won't go into this. I'm going to save the time for the panel but we've produced some reports. Joe Palladino talked at the last meeting with the EAC about three months ago and provided you these results.

We have met all the goals here that we hoped to meet from a performance perspective and all this information is up on smartgrid.gov. So I want to start our panel and that will help frame the situation and we'll start with David. We'll start with David Wade first.

David helped lead the EPB, build the electric smart grid distribution system at the electric power board in Chattanooga and has 27 years of experience. And, David, I'll let you go next. Let me get my things out of the way here.

MR. WADE: Well, thank you. And it's a privilege to be here and we feel very privileged to have the opportunity to participate with and work with the DOE and work through the investment grant. I think it has been a tremendous benefit to our community and will continue to be a benefit to our community for many years in the future.

We're a municipal utility. We serve about a 600-square mile area around Chattanooga. We have around 175,000 homes and businesses that we serve. And just to give you a sense of context, we're about a 1,300 megawatt system at our peak demand.

So a little bit of context of what our size and shape is, Chattanooga has pretty much went through a community revitalization over the last 20 years and turned into from what was a dying community to something that's thriving and growing today. That we're glad to be part of that as well.

When we started, when the investment grants first came about, we were, yeah, sometimes you think it's good to be in the right place at the right time and timing's everything. We felt like that was one of the things that was very well for us. We had put together a business plan and a long-range look at where we wanted to be in the future with modernizing our grid and had went out and funded an initial phase of that.

And almost as soon as we issued our bonds, it wasn't just a month or so later before the opportunity to apply for a grant came out. So timing really was great for us and we were able to really expand and run through multiple phases of our long-term project pretty quick and show some really big benefits to our community.

When we started looking, one of the things that we saw everywhere we looked at making an electric system that was intelligent, interactive and self-healing, communication became one of the basis that we was a missing link. So one of the things we did is install a fiber optic network throughout our entire service territory.

We did that because we felt like that was a way to future-proof our communication needs. We knew that communication was going to continue to be more critical to our electric system and we wanted the ability to easily layer on devices and get information back.

We also -- automating our network had significant impact. We have a system design that, a legacy network as we talk about transitioning from legacy to today's network that's not a legacy that most people would have wanted, 10, 15, 20 years ago. As a legacy that kind of inherited was a legacy of having a 1,300 megawatt system with 115 substations.

So we had a lot of postage-stamp substations, a lot of 10 MPA substations, but it caused us to build some pretty decent ties between them because they were redundant from each other. Which when you layer on distributed automation, turns into really a network that, what was a strategic disadvantage all of a sudden becomes a strategic advantage.

Now, we have about 1,200, a little over 1,200, of the S&Cs intellirupters on our distribution network. If you remember what I told you about our size, we're around a 1,300 megawatt peak demand. So we're about a megawatt of load between each of our switches.

We've also automated our subtransmission network. We have a 46 KV subtransmission network. We've also automated that. When we started down this, our projection was that we would see a 40 percent improvement in reliability. Every metric we look at, we've exceeded those targets. You know, they really vary based on which metric and which time period you look at but typically I see 48 percent up to well above 60 percent depending on what metrics I look at.

A couple of quick numbers I'll give you as an example. SAFI for us was right at one-and-a-half, just under one-and-a-half before we started, the year before we started this project. This year we'll end the year I think at pretty significantly under a point seven. So and SATI was 112 minutes. We'll end the year this year, and our fiscal year is from July 1st to June 30th. This year we'll probably end it below 45.

So we have seen some significant changes there in reliability. Our customers notice it and I think it sets us up as not only just for a short-term gain of reliability, it is by having the densely populated automation and having the ability to communicate with these switches, you know, and what was a legacy system that was a disadvantage, all of a sudden now we start talking about distributed energy sources. When you have a distributed delivery system applying those, becomes pretty doggone easy.

So we see that as an advantage as we move forward as well. We've installed metering throughout our system. The biggest surprises there was that now we know what kind of service we're providing our customers. There was some -- I think we realized when we went into it we would know, would find every mistake we made and we're still finding those.

You know, we found where we had taps set on the wrong settings. The biggest surprise was the number of alarms that we were getting on the high voltage side, the swell side and dealing with those. We've changed operating procedures around how we use automatically switched capacitors and our strategy around how we put capacitors in our system since we had this data.

So we're still learning. We've updated all of our (inaudible) systems, our OMS, put in a DMS to integrate with these products. And let's see. I don't have a mouse here. I don't think, is there a mouse?

Okay. Well, I don't think I can show you this but I will tell you what one of the things that I think is pretty important for us to think about from time to time, maybe it is playing. Let me back that up then. Okay, if it's going to play and I'll show it to you before I go -- we started thinking about how do we communicate with our customers, you know?

And because that becomes one of the missing links for us as an electric utility is we probably don't do as well as a lot of industries in communicating with our customers. What I want to show you here is just an example of one of the ways we've started learning now to communicate with our customers and it's basically a take-off of the weather radar.

When you -- the yellow that you see there represents, there's a geograph -- geospatial yellow dot for every meter that we have on our system that is energized and working. This was a storm from right after we installed our automation. And the red, this turns red when a customer has an outage even if it's only a few seconds. When that outage is restored, if it's restored through our automation, it turns purple.

So you can see as the storm was blowing through the stuff was turning purple and as our crews get out and do physical work to restore service it turns green. So we're looking at how do we communicate with our customers in a new way, in a different way and we think that's part of what an electric system of the future really is, too, improving communication with our customers.

It's interesting. This also gives us a way to communicate with our internal resources. You know it's much easier to have that last bit of energy to finish something when you can look back and see how far you've came. And a picture sometimes is easier to see than words. So that's just one of the ways we've started learning there.

I think as we move forward, we're still learning every day. We're getting lots of information in and data and we're starting to work with folks like Oak Ridge and EPRI and the DOE just to see how can we take and leverage that information even further.

One of the probably unique opportunities that we have that I'll just mention a couple of them, one is that through this process over the last couple of years, we've captured over 10,000 wave forms on our distribution network. And some of those wave forms are where an event started timing, these intellirupters capture wave forms and when event starts timing, it captures a wave form even if it never operates.

Then we have some that operated but they pulsed and reclosed into a temporary fault and nobody saw a sustained outage. Then we have sustained outages. So we're starting to look at, and that's a pretty large library of wave forms for us to start to evaluate what's it telling us and how should we operate our system differently or how do we know of incipient, pending stuff because of these type of information?

Next, we see layering on some more

distributed energy sources. We are starting a project to put in some community solar. We want that to be interactive with the grid and not a stand-alone supplemental system, too. So we think that it's been a great opportunity to work with the DOE on this and it's been really beneficial to our community.

CHAIRMAN COWART: Thanks, David. So we'll go through our presentations and then, we'll have questions afterwards. Next speaker, Vickie VanZandt currently consults with North American clients on electric transmission matters and is director of ISO New England, Inc. There you go, Vickie.

MS. VANZANDT: Good morning. I'm from the west and spent oh, I don't know, three-and-a-half decades or so at Bonneville Power Administration in their transmission business. So I was the program manager for one of the largest, well, actually, the largest electric smart grid investment grant. It was $108 million and it covered the entire interconnection.

So I'll be describing that. First, I don't have to describe this to you. You know it really well that from an operator's perspective it used to be a little easier than it is now. Central plant, stable, predictable, long-term commercial arrangements that changed only seasonally in the west, generation with lots of mass and therefore lots of inertia and I think the impact of low mass things is just now coming due. And voltage dependent load, we had a lot of industrial processes in the west, particularly in the northwest and if the voltage started to dip, the load went down and gave you a break.

So pretty good conditions for system operators. Today smaller distributed generation and demand-side measures for which the grid was not designed, lots more transactions that change in five-minute increments and the generation fleet characteristics have changed. A lot of intermittent low mass machines and a less inertial response to a rest, a frequency decline should you have a disturbance.

And finally, the load has changed, too. Less industrial load more computer, air-conditioning, service. When I was graduating from college in the '70s in the northwest nobody needed an air-conditioner. Now, everybody has it and that's very VAR hungry load. So it's a tougher environment.

So that means that the grid is more complex and harder to operate and demands better modeling and better visibility. That's, all else being equal, we need an increase in that in order for the operators and the grid managers to cope. So no matter how carefully the operators operate, if the models aren't right, simulations are used to set transfer limits on transmission and if the models are not right, then the limits are not right.

They might be more conservative and that means monies left on the table or they might be overly optimistic which means reliability is at stake. And if they can't see what's happening then they can't fix it.

So here's an example of poor modeling. This is an oscillography trace of the power on the AC intertie at the California-Oregon border. And the disturbance was a separation between BC and Alberta. It was carrying 300 megawatts at the time, hardly anything, clear at the end of the north end of the system. That's what we thought would happen pretty well damped oscillation and this is what actually happened.

It was a summer oscillation and I just happened to be on the dispatch floor on that day and you should have seen -- you could whites all the way around the irises of the dispatchers. So that's what actually happened.

So the model was not right. And if power system phenomena can't be seen, operators aren't aware of the vulnerabilities. We have a couple of system-wide oscillatory modes in the west,.25 Hertz and one that's.4. North-South mode is.25 and if there's a lot of energy in that oscillation then there's a reliability concern. And up to the end of the smart grid grant, there was no visibility of that anywhere except for just a couple of spotty places.

Some not on the operating floor, in the engineer's evaluation room, southern Cal could see it, Bonneville could see it but it wasn't widespread. So SCADA can't really help. The red trace is what SCADA saw on this.

If you have PMUs then you can see clearly that you've got an oscillatory behavior and a growing concern. If they can't see it, they can't fix it.

So the smart grid grant that was called WISP, Western Interconnection Syncrophasor Program was widespread in the installation and deployment of a lot of PMUs. So we just happen to have some of those. It's necessary for the visualization and for automated controls which we intend to deploy.

So that's the PMU deployment. Pretty big deal. In the WISP grant, over 300 were deployed as a part of the grant and as part of that program, we determined a PMU placement criteria to say this is where we would like to have them. For instance, any load center that was more than 750 megawatts, any plant that was bigger than X, I don't remember what that was, any major path and so on.

And we applied that over the whole interconnection. We had nine partners in the smart grid grant; one federal entity, some private entities, investor- owned utilities and some publicly-owned utilities as well. And then, after we applied that criteria on the west, we didn't have PMUs from -- all the PMUs we needed were not among the nine. So we invited 10 additional participants and 9 of them, actually, there were 11 and 10 accepted.

And they spent their own money to put in the PMUs and the communications. And for the benefit of seeing the wide area view which was part of this grant that was going to be available to everybody.

One kind of unexpected benefit, you know how data sharing is kind of difficult? We needed to be able to share data. So parties were pretty concerned about particularly generation outage data, getting out to market participants. And so, what we did was develop a reliability portal and in order to get access to that you had to be a TO, a TOP, a balancing authority or a reliability coordinator.

And access to that was restricted. We posted all the information on that portal and parties, if they executed a universal data sharing agreement, then you provide data and anybody who received it had to be one of those parties and they agreed to protect it from those who participate in the market. So that was an 18-month endeavor to get everyone to participate in that universal data sharing agreement.

And we got them all, everybody. Generators, the green spots are those who share data with each other and the blue spots are those who are willing to provide their data but don't need data from others. So smaller utilities who don't operate necessarily. So that was a big win.

And it's been useful for a variety of other data exchanges, too. This didn't just involve PMUs but any operating reliability data. Okay. And the data sharing. If you look at the western interconnection, the thick red lines are between RCs. The data exchanges between the reliability coordinators. So, there's one in Alberta and WEC -- or the breakoff of WEC. Peak Reliability is located in Vancouver, Washington, and in Loveland, Colorado. So, that's what the red lines are.

The other red lines are between participants -- or dataflow to the RCs. But if you can see, it's kind of faint but the green lines represent data exchange -- PMU data exchange among the participants, so between utilities, and that's really a great feature. I think that's the only place that is occurring.

And the modeling. So, PMU benefits -- modeling is one of the great big ones. Of the three components, transmission, that's pretty good. Generation modeling is poorer, but it is improving. And loads needs the most work.

Do you remember the trace I showed you with the model? Let me go back to that. There it is. The difference between assimilation and the actual event ended up to be incorrect load modeling. More resistive load was modeled, and less inductive load was modeled. So, we increased the inductive load modeling by 20 percent and was able to match that. So, the PMUs are going to play a big role in helping us improve the models.

This is a generator model validation. It was the first one that we undertook as part of the Smart Grid Grant. The upper -- before calibration on the left side, the input -- or the disturbance -- is the same, and the simulated response, or what we thought would happen below that on the left was the red trace. And what actually happened was the blue trace, so something's wrong with that generator model. We took four disturbances, calibrated the generator model, and used 10 additional disturbances, subsequent ones, to validate that the calibration we'd done was correct.

So, after calibration, the same input -- look at the actual response, and the blue and the red match quite a bit better. Now, that's been extended to many generators in the West, and that means our simulations are going to be much better, and our limits are going to be much more accurate.

So, why WISP was unique. It was the biggest one of the electric transmission category. Public and private folks deployed -- this is a killer benefit, this next thing, the dedicated, secure, high-speed wide area network for synchrophasors -- we deployed, as part of the grant, a dedicated network that is managed by Harris Corporation, and our NOC center is in Melbourne. They look after it. They have a dedicated cyber security team that watches it every minute of every day, and it's fabulous. It is high speed. It is low jitter. The latency exceeded our spec requirements. So did the jitter. So, that's one long- lasting benefit of the Smart Grid Investment Grant. And it's carrying PMU traffic now. I believe it will carry additional traffic like, maybe, ICCP in the future.

Okay, visualization of power system oscillations. As I mentioned earlier, that's a particular vulnerability in the West along with decision support for mitigation. And we're going to deploy two -- the infrastructures in, it's being monitored now -- but two response-based controls where the input to the automated control action is PMU input. They're both being deployed Bonneville, and one is related to wind, and the other one is connected with operation on the California-Oregon Intertie.

Okay, so what's next? Qualifying the data. Lots of data issues. One PMU is convinced it's 2037, and we can't get it to think otherwise. So, calibration -- you know, some of this is related to perhaps capacitive CCVTs. They are less accurate than wire-wound instrument transformers, so you need to make sure those are tuned up well so bad data detection -- you want to make sure you don't lose packets in the transmission and that things arrive on time. The synchronization of these time measurements is a critical and important benefit also.

I worked on the 2003 blackout investigation, and it took us -- I don't know, David -- four months, I think, to get time alignment of the various data packets from the impacted utilities, and now that happens in an instant. So, this is great.

Interconnection baseline correlation. So, we now have a measure of damping in the West, and the power system in the West is not all that well damped anymore. But what's adequate? Eight percent? Probably. Five percent? Probably. Less than five? Not sure. Down to two? Probably a problem. So, we want to get some baseline correlation of angles and oscillation energy and calibrating and validating the models.

And then, finally, dynamic simulation or simultaneous limits. You can transmit on the coy up to 4800 megawatts but not if the DC intertie is running at 31. So, that is one feature that we intend to work further on and to determine corrective actions for stress power system stakes.

Coping with the loss of inertia. It's just not the same frequency arrest that we used to have with higher mass machines. Low-damping, high-angle separation. That was a factor in 2003 -- high-angle separation. And some actions will be automatic.

So, I would like to underscore some things that Jeff said about the coordination framework. I'm a student of John Doyle's also. Power systems are fabulous engineering marvels. And they're very robust for maybe one or two contingencies, but when you get deeper -- three, four, five -- they are quite fragile. And the disturbances -- big disturbances, like 2003 and in the west 1996 -- those big disturbances happen more frequently than a normal distribution would indicate. So, power systems have heavy tail-type power law distributions, and the changes that we're seeing in the electric grid on both the generation and the load in the distribution segments -- all else being equal, that fat tail is going to be flatter yet unless we deploy some controls, some mechanisms, some better modeling, some better visibility just to stay even.

Okay, that's it for me.

MR. KENCHINGTON: Thanks Vickie. Cool stuff. Very cool stuff.

And I said we were going to hold questions till the end, but I made the rule so I'm going to break the rule.

(Laughter) You talked about you've come up with a way to

Determine how many PMUs you would need and where to put them? Is that particular to the western connection, or is that applicable, would you say, to other regions?

MS. VANZANDT: I think you could deploy it elsewhere.

MR. KENCHINGTON: Okay.

MS. VANZANDT: I'd be happy to share it with you. NERC helped us with that.

MR. KENCHINGTON: Okay.

MS. VANZANDT: And the Smart Grid Investment Grant participants worked on it together.

MR. KENCHINGTON: Okay.

MS. VANZANDT: And it's based on engineering rather than PMU for any substation 100 kb and above.

MR. KENCHINGTON: So, there are analytics behind it.

MS. VANZANDT: Yes.

MR. KENCHINGTON: Very good, thank you. Okay, our next speaker, Karen Lefkowitz with PEPCO. Karen is the Vice President, Business Transformation, and the Chief Information Security Officer.

MS. LEFKOWITZ: Good morning, everybody. First of all, I'm stealing from David that animation on how to represent analogies and restoration to customers is brilliant, and I'm going to absolutely steal it, and I'm going to ask Vickie for the slides on the oscillation disturbances and share that back. This is really interesting stuff. And let me start by saying that I'm going to sort of focus on the distribution side and what we've done.

This is a slide I use when I speak to community groups a lot, because one of the things I know is that people really don't understand what a smart grid is, and they typically think smart grid just means smart meters. So, one of the things I try to explain to people is that the smart grid means that we're acting on all aspects of the electric system starting with synchrophasors on the transmission side; digital substations; advanced technology inside the substation walls; automation out on the poles and wires for feeder distribution automation; and then of course focusing in on the home both smart meters and smart thermostats. We're right now piloting with DOE money a smart inverter project, as well as looking at using EV chargers as demand response tools.

And along this entire pantheon of things, we had a lot of help from the Department of Energy through our ARRA grants, and of course now that I'm the CSO as well, I have to say that we have built security in along the entire chain of the telecommunications piece.

And the other thing that I say to people when I'm speaking in public is the very same thing that enables all of us to have incredible computing power in our pocket with our smart phone is the same thing that enabled most of this technology to work, and that is cheap ubiquitous -- inexpensive ubiquitous telecommunications.

So, we're done deploying. And I guess I should mention -- I did include a slide. For those of you who are local, you know that PEPCO is the local provider in D.C. and the suburban Maryland areas. But we also are the company that operates in Delaware and South Jersey -- so, everything from casinos, farms, lots of agricultural area, suburban to a very dense urban electric system. And we had a design and a set of programs that we wanted to roll out in all of our territories identically. The only exception is in

New Jersey we did not get approval from our local regulators to deploy AMI, but we do have distribution automation there.

So, one of the things that -- I was very confident about four years ago when I joined this project that this was all going to work. But it turned out that not everybody was so confident, and so we can now say with 1.4 million meters installed, the technology is actually working the way we expected it to work.

One of the things that we did, because you may not know, I have very, very tough regulatory environments that I operate in on the distribution level. And so our strategy was to go in and define a small set of actions and benefits that we were going to deliver and hit it out of the field with those benefits. And then when we had those in the bank, we would start deploying and leveraging further the investment that the Department of Energy helped us make in the grid. So, the set of things that we told our regulators we were going to do is over (inaudible); outage detection and outage restoration notification; automatic sectionalizing and reclosure, so the distribution automation function; remote connect/disconnect. We were going to push all that data out to the customers, and we were going to come up with innovative new price programs that of course they had to approve and we did in the form of critical peak rebates. And so that's what we said we were going to do, and we made sure we did them in all of our jurisdictions except for New Jersey without the AMI data.

So, everything is working, and everything is working really, really well. And that's not to say there aren't problems. One of the things utilities have to learn is how to manage a telecommunications network that's touching every end point that now includes every premise. So, the communications system always needs some tweaking. We need to add relays. We need to move them and things like that. I don't think that we anticipated as much change in that once it was installed that we're experiencing.

But I always try to tell people it's a good thing. It means new buildings are going up, right? That means more revenue coming in one way or another. So, there's an upside to that.

One of the things that -- before I talk about the next steps, one of the things that we're in the process of doing is preparing for recovery in the state of Maryland. So, the state of Maryland actually asked us to do something different than what we ordinarily do in the regulated space and distribution, which is normally we go in, we say we want to do this big project and they say: That looks good, you get approval, then when you're finished come back and we're going to evaluate your cost based on prudency. Right? Did you spend your money prudently? We're only going to allow you to recover prudent spend.

In Maryland, they changed the game, and they said: You have approval to go ahead, but we want you to come in and prove, with actual numbers, that this was a cost- effective program.

And that is a very big change. And one of the interesting things that we're -- the exercise that we've had to go through is find ways to quantify data savings direct to customers. So, we all are comfortable with talking about operational efficiencies, voided O&M, and changing the way we do our capital spend, but we're not necessarily as good about thinking: What have I done that has saved the customer money? And some of those benefits are not benefits that we manage. And the best example is conservation voltage reduction, right?

We are using AMI data. This is a huge win. We have now got conservation voltage reduction running on at least 40 percent of the residential feeders in our PEPCO Maryland territory. And customers are -- the voltages reduced approximately 2 percent. Customers will estimate that savings to about 1.5 percent on their bill. Customers don't know it's happening. Not a single person has called to complain. We think that's a huge win. Customers don't know it's happening. They don't know that we've enabled them to save money, and that's not a huge win. And now what I have to do is to say in a regulatory model -- in recovery, I have to say customers save 1.5 percent; aggregate that over all the customers affected by that change to their feeder, and look at that over a 10-year period. That is a very, very big number, and nobody noticed. Right?

So, it's sort of a hard sell. It's a classic double-edged sword. We think it's really a smart thing to do. We've used the AMI data to do a very deep evaluation of the power quality across each feeder prior to turning on CVR. We have found a couple of places where there were big problems that we were able to solve that we would not have otherwise known. So, it's a big win for customers.

Dynamic pricing is a very interesting program. We do a critical peak rebate. Customers have really benefitted from that and, surprisingly, have been willing to embrace it, although I say that with a caveat because the last two summers that we've run this program, for those who are local know, it's been very, very mild. So, we don't know how customers are going to behave when they have a really hot summer, much more typical summer, around this jurisdiction.

So, what's up next? I am famous for saying the technology -- even though I'm a technologist, I ran system operations; I started out in the IT world. I know technology isn't easy. But the technology part of what we've done is actually the easiest part of what we've done. The hardest part of my job is convincing people to do their job differently than they did before, getting them to think about how we solve problems that we have in the business in a different way using different datasets. And the way we're going to approach that is changing wholesale by looking at what the analytics use cases are that are available to us and pushing that out.

So, we sort of sat down; we pulled all the use cases we could find across the industry, some we've heard other people doing, some that we saw (inaudible) pulled together something, a paper on this, some that we just sat around the table and thought up ourselves. So, we've got about 50 use cases here, and we categorized them in a way that made sense for us. You could put these in different categories, and now we're taking a look at the actual individual use case. Where do we have resources available to work on things? What things are going to provide the biggest benefit? What things do we have technology that we already have that we could leverage without doing a lot of extra spend. So, we've got a roadmap that takes all this into account.

But the big thing here -- and it's something that I tell my colleagues all the time -- instinctively we go for the low-hanging fruit. That's a phrase we use all the time. What's easy to deploy? What's a small change that we can get some wins under our belt? And I'm not sure in this case that's what the smart thing to do is.

I think that what we want to do is

demonstrate, in a really showy way -- and now you've got to think what's showy to an engineer -- how we can use data differently. So, one of the examples that I like to give is in the Metro area around here we expect that electric vehicles are going to take off at some point, and that's in the not-to-distant future. I should say I expect it. A lot of people argue with me about this. And they argue with me about it for all the wrong reasons. They always say it's more expensive; consumers aren't going to want to buy it; it's not cost effective -- at which point I say: Tell me what the business case is for buying a Lexus or a BMW, because I'm pretty sure they're not cost effective either. So, I think that customers are going to buy what customers want to buy. EV manufacturers are marketing heavily in this area. They're making it fun, sexy, cool, hip, whatever it is. They're appealing to people. They're spending all that money marketing, because they know marketing works, and customers are going to eventually start. Once that ball starts rolling, we all know you reach an inflection point and it goes really fast. Utilities don't move fast.

So, this is one of those areas where I suspect we're going to need to stay ahead of the curve. How are we going to stay ahead of the curve? We're going to look at a different set of data than we're accustomed to looking at. We're going to have to pull in consumer propensity data so we have economic data that's out there that everybody else in the universe uses but not regulated utilities that tell marketers where to market and where they're likely to have success. So, look at Zip Codes; look at income; look at all kinds of stuff that I don't know anything about. Now, take that data, overlay that on the electric system. Find out what transformers are at risk for multi EV purchases in it. Target them and figure out how. If you're doing a feeder upgrade or if you're doing improvements, maybe you just bite the bullet and put in a slightly bigger transformer. Maybe you do what we've done in Maryland, which is come up with an EV tariff that encourages customers to shift that load to a different point in time.

But what we're talking about doing is pulling customer behavior data, overlaying it with electric system design and electric system planning, and thinking about it differently. So, people in the customer space or customers looking at customer data, people on the electric system side are accustomed to looking at all of the things that we're comforted by in the grid. Rarely do the two interact.

So, that's the big thing that I think is going to happen. I'm encouraging us to look at those things. There are a whole bunch of use cases around: High-penetration solar, which we're starting to see in New Jersey of all places, and certainly we would expect to be seeing it in other parts of our territory relatively soon; EVs; and then, of course, this laundry list of other things that we're doing.

So, I think this is absolutely the most exciting time to be in the industry for me. I've worked in everything from IT to system operations transmission, and now back in the customer space on the grid side doing smart grid, and I can't imagine a better way to spend my day than thinking about how to make this stuff make sense and how to make it work. And -- hopefully -- you all represent different segments of this energy industry -- and hopefully you find it as exciting as I do.

Thank you.

MR. KENCHINGTON: Very good, Karen, and thank you very much.

So, next speaker, Craig Miller. Craig's with the National Rural Electric Cooperative Association. Thank you for hosting us today.

MR. MILLER: I like to commute. You know, five floors of elevator was great. Need more meetings like this.

The first thing I want to mention is that we were supposed to finish our talks as of five minutes ago. In order to preserve time for questions, I'm trying to be as succinct as possible.

Second thing, I want to note that I absolutely hate being on a panel with David or any other dudes from Chattanooga, because they're damned showoffs. (Laughter) That is an amazing bit of work, okay?

Now, third point, I'll stipulate that I have gorgeous slides that are incredibly elucidating. I turned them in last week, late but before the presentation, and then on Monday we got the questions we were supposed to answer. And I sat down on the weekend and I said, damn, these don't match, okay? So, in deference to your purposes, superior to what I wanted to say, I'm going to answer your questions first. And if there's a little time left over, I'll talk about the cool stuff that I like.

Now, we were supposed to say: What do we do? What did learn from it? What could we have not done without DOE? And then: What are we doing next?

So, what do we do? NRECA is not an

electric utility. We don't own any assets, okay? But we are the trade association of more than 900 cooperative utilities. We cover about 75 percent of the land area of the United States that have 50 percent of all the distribution line, control 55,000 megawatts of generation, and have 16 million meters. So, collectively, we're really big, even though individually we're pretty small most of the time.

So, what we did when we got this grant from DOE -- when we saw the proposal, the funding opportunity -- is we went out to the 900 and said: What cool things do you want to do? And about 65 utilities came back to us with ideas. And we had a big meeting, actually in this room, and we hashed ideas out and put it together and we came up with a project that was distributed across 23 utilities in 10 states and did 89 individual subprojects. So, we've looked at a lot of different things. We looked at smart meters, of course, but we also looked at advanced meter data management systems, meter data management systems where a generation in transmission entity looked at the meter data management of the distribution companies in order to coordinate over a wider area. We did an awful lot of smart feeder automation, okay -- because we have half of the distribution lines in the United States. So, feeder automation, distribution automation, is really important to us.

So, we did a lot of smart feeder switches. We looked at very advanced techniques for SCADA. We tested conservation voltage reduction on long rural runs where it's not traditionally used but we proved it worked. Ultimately, we completely all 89 of them, and I've got to brag here for a sec. We finished two weeks early, 1/16th of a percent under budget, okay? (Laughter) I was told by God: Don't go 1/16th over. And so we finished, and what we did is we produced a really unconventional final report. In particular, we produced 11 different ones. What we did is we studied different aspects of the project and we put out little single-purpose manuals -- just generally 30, 40, 50 pages -- to explain to people how to do what we did. How do you build a multi-tenant MDM? How do you determine if CVR works? What is the real ROI on smart feeder switching, and where do you install it? Because, like I said, we're not a utility.

Finishing the work is not the end of the project to us. Our mission is to motivate our entire community and to help our colleagues in other aspects, in other areas of the utility community to continue to improve. So, this project, for us, was the beginning, the beginning of a fundamental transformation in the way we approach the modernization of the grid, okay? And it's continuing.

Now, there were two other aspects in the FOA -- I'm a hyperliteral person, so I think I committed it to memory -- and one of them is it said we had to deploy everything securely. And after we sort of got up off the floor rolling, laughing, you know, at the request for the impossible -- excuse me, Hank -- we sat down and said: What are we going to do about this? We decided that we couldn't guarantee that everything was going to be deployed securely. I went out and I hired a company to look at the inherent security of the smart grid technology, and they came back -- and I'm going to give it to you word for word: "We cannot positively attest to the security of any component currently deployed in the U.S. electrical grid." It could not look at the software there and guarantee that it couldn't be broken.

So, we've just determined that the parts don't work, that they're vulnerable. So, how do we improve security? We said: Let's not set a high goal, let's set a realistic goal. Let's create a paradigm where we do continuous improvement to make ourselves more secure in 30 days, more secure in 30 months. Just step by step by step. And we wrote, using ARRA money, guides on how to do this. We put together a very extensive, very detailed guide with 600 references on how to do it, and we sent it out and everybody said: Wow, this is wonderful. And I'm talking to some of the co-ops who reviewed it, and I'm just feeling fabulous because they're saying wonderful things. And then he says: And if you ever get a version in English, be sure to send it to us.

(Laughter)

So, we went back and we started simplifying it -- you know, making it shorter and shorter -- and then we built a template for an organization to help build a cybersecurity plan that they can continually improve. And then we built procurement language, and we put together a whole suite here, and this is a number that's kind of cool. It was downloaded -- the collection of everything that we wrote with ARRA money -- it was downloaded 34,000 times. That's a best seller. I don't think you can find a single cyber security reference, including NIST's, that's been downloaded as much. The ARRA Grant created an understanding of cybersecurity that's propagating. It altered the dialog. It gave people the confidence to start.

One of the important things whenever you talk about a new technology is to have a start button, a big red button. The first thing you do. So, what's the first question we ask? Who's the boss? Who's in charge of cybersecurity? That's an easy question. Everybody can answer that, okay? So, they get their momentum up. 34,000 downloads. Second iteration out there.

The other thing the FOA said was that we had to improve interoperability, and we took that very seriously. So, Ann Arecia, of course, is the author-manager-owner of the MultiSpeak Standard, which is the most widely used interoperability. I know we all talk IEC, and we talk IEEE and various other areas, and fabulous stuff, absolutely essential, but we have 900 utilities using MultiSpeak, including large ones like ESCON, Électricté de France, Southern Company, (inaudible) Company. So, anyway.

What we did is we made it better. We put an entire new iteration in, wrote more than a hundred use cases, put it on a firmer footing for the future. We also developed standards-based security, and this is very important. Standards and security are two sides of the same coin. If you write a strict standard that tells you what that device or that software should do and should not do, it gives you something definitive to test. You verify that it does what it's supposed to and doesn't do anything else. So, we decided to embed security into interoperability standards. We did it. It's in MultiSpeak 5. It has also been adopted by the IEC -- the same approach.

So, Smart Grid Grant. We said we'd deploy 250,000 components at 23 co-ops testing 89 projects. We deployed 455,000. I was a little disappointed. I wanted to double what we promised. What could we have done without DOE? None of that. This encouraged our community to take steps, to try things that they wouldn't have done before. And what did they accomplish? They provided rock-solid demonstrations of what works, which we documented in our reports, and now those same sorts of activities are continuing across our entire community.

What did the Smart Grid Demonstration Grant accomplish? And I'll do this real quick here. The question we asked in the beginning -- I'm sorry, what do I press here? -- do we need a new grid? Okay, I'm going to do this in two slides. Question No. 1: Do we need a new grid? We asked ourselves that? In 2000, the National Academy of Engineering decided that the grid of the United States was the greatest engineering achievement of the 20th century. It is spectacularly reliable. Yes, I know there are other countries that are more reliable, but it's a pretty darn good system, given the extent of what it has. Secretary Muniz a year ago February defined the grid as a continent spanning machine of immense complexity that is at its best when it's invisible. Isn't that a cool definition?

So, I read yesterday that CERN was the biggest machine ever built. Hell no. We've got one that spans a continent, okay? And it works. Do we need a new one? The answer is: Absolutely not. But that's not the way engineers work, right? By nature, every time we do something we ask: Can we do it better? Can we do it better? Is there a better way of doing it? Okay? And what the smart grid is, is a better way of doing what we have always done. And what the Smart Grid Demonstration Grant and the investment grants did was give people the courage to take the step to do it better instead of just doing it the way they always did. So, what did it do? It accomplished its very specific objective of showing the opportunity inherent in the emerging technology. It gave people confidence and moved them forward. It made massive improvements in cybersecurity, massive improvements in interoperability. I don't believe I've ever been involved in a more effective program. And this report you guys put out should celebrate this extraordinary achievement. If it doesn't, you got it wrong, okay?

And then what happened -- the legacy it left for my organization is we decided where we needed research, and we came up with this little flower -- I'm sorry, "cybersecurity" shouldn't be highlight except I worked there so much -- we decided these were the seven areas where smart grid research is needed:

•Distributed generation, obviously.

•Agile control. That's smart switching technology; that's storage; that's active for our control; all the solid state power electronics going towards an actively managed grid rather than one managed by mass.

•Advanced communications. Every single project we have ever undertaken in smart grid deployment, starts with communications. It's a tough problem. Massive research is needed to solve that to make it accessible, particularly to our less technically staffed co-ops. They aren't dumber; they're just smaller, okay?

•Advanced analytics. The future grid is not an easily designed thing. We do most of our modeling, frankly, as if they were D.C. circuits even though they're A.C. We don't look, in general, at the design phase at issues around harmonics and VAR right off the bat. The current analytical tools is not adequate for the level of design we need to do.

•Big data. Actually, we don't have big data, even compared to the people out West. What we have is very special data, data where we have concerns about latency, reliability, tolerance of error rates that we have to take advantage of. We need massive issues in data management.

•Cybersecurity. We are making progress on cybersecurity. The important thing to remember here -- this is a number you guys haven't heard before. It's 229. I think it's the number for 2015. Just remember 229. That's the average length of time from a cybersecurity breach occurs until the door is closed. It takes that long to find out you've been hacked and to fix the problem -- seven months. So, if you want to improve cybersecurity, yes, find the bad guys, improve the software, do all kinds of things - - and they'll give you good 10 or 15 percent improvements. What we need to do as an industry is shrink 229 to one day. And that's a 99.5 percent improvement in cybersecurity, okay? 229. Remember it.

•The last bit is architecture, and I'm seeing my new best friend over in the corner there -- hey, Jeff. We believe that the solution is ultimately an architecture, and we're going to have some phenomenal conversations, because he's a smart guy and I'm not too dumb. We believe that the foundation for future architecture is not gluing things together -- and I'm talking the architecture control system -- but getting the data right, because all applications ultimately intersected the data. A pole has a location, a conductor has a gauge; there's a current flow, there's a voltage flow. Those are absolute facts. Every application has to access the same data, so we view the future architecture as being data centered.

So, these are seven areas working in the future of the grid. We have a vital program going on now. It would not exist without the ARRA grant, and we believe that what we're doing and what our colleagues are doing here -- including the damn showoffs like all three of you are -- are really accomplishing amazing things.

Thanks.

MR. KENCHINGTON: Thank you. Fantastic, fantastic.

So, now I think it's best to -- we have until 11:20, is that right, Rich?

CHAIRMAN COWART: Correct -- well, including discussion to 11:40.

MR. KENCHINGTON: Okay, so I'll open it to the audience for questions. I think you all have a protocol with (inaudible).

CHAIRMAN COWART: Questions, comments on what we've heard. We've heard quite a lot.

MS. REDER: I guess I'll start it off. David, if you could just talk a little bit about the importance of changing the conversation. You know, you had the map with the different colors and kind of the importance of turning in a 180 as you interact with the customers and where that will likely take us.

MR. WADE: Well, I think it is what's going to drive us totally. It kind of dawned on me, a couple of things happened a few years ago that kind of resonate still with me into how this conversation exists. We did a focus group with our customers, and we were going after what type of rates would incent them to do stuff, and we really started at -- they didn't know it was us -- they started asking questions about purchasing gas, and they finally got around to talking about electricity and we asked them what their average bill was and they knew it right off the top of their mind what their average bill was or knew a number. I'm not sure it was right or not. We didn't try to validate it. But then the next question was: Put your own number in. You said you pay $120 a month. What do you get for that? The scary part was the whole room was silent, and the moderator let that silence exist for almost a minute where it was so uneasy, and then the moderator finally said: Well, do you get stuff like food that doesn't spoil or a comfortable home? And they were able to catch on. It wasn't they couldn't get it. It was at top of 00:41:17 mind -- they had a bill top of mind, but they had no value associated with the top of mind. The same thing happens when we think about our electric system and reliability and stuff. You know, we all know what happens when a storm comes through any area, that what's always put at the front is how many are left out. If that's 200 out of 2 million, it's still the number -- it's not that that many -- it's always a story that way.

I had a call right after we started deploying our automation -- we really didn't have any of it in automation schemes yet -- from one of our vice presidents, and she called me one Saturday and said -- she was just kind of giddish: I think I saw our smart grid working. I said: What do you mean? She said: My lights went off and came back on. And I kind of said: Well, that was the old- fashioned reclose. And I laughed a little bit with her about it, but what donned on us there was, you know, since we didn't tell our customers even stuff like that from the '50s, '60s. When reclosers came into existence, there was always something that prevent our customers from having a longer-term outage. They were not a bad thing, but since we chose, as the industry, not to tell folks it was good, it's a bad thing. So, I think it's important to tell customers what. So, if not, they don't know.

MR. MILLER: Dave, can I add something to that? Could you just -- we tested what you call a meter, and we found out that people object to smart meters -- some of them do. We didn't find anybody who objected to a better meter. So, just stop calling them smart meters and say we're putting in better meters. Nobody objects. Tell them it's good. You don't have to -- (laughter).

MS. LEFKOWITZ: Well, I was just going to add on that the biggest win that I had around the meter program was I had virtually no customers. In comparison to other places, we had very, very few customers who were unhappy about getting a meter, and I completely believe it's because I shunned the media. I muzzled my corporate communications people. We communicated directly to customers with direct mail campaigns and door hangers. We didn't invite the media in to run stories until we were done.

CHAIRMAN COWART: Sonny?

MS. LEFKOWITZ: Yes, thanks, and a terrific panel. It seems to me that, you know, one of the clear victories here has been, from what we've learned, is the benefits for outage detection and restoration, and I've seen lots of great information from Chattanooga on that issue. And now it sounds like you've had similar results in PEPCO, and my question, then, is for Karen.

In terms of the benefits of, let's say, distribution automation versus -- shouldn't be really "versus," but to say as opposed to AMI, you're almost a perfect case study, because you've got both the distribution and automation at AMI in, what, Maryland and Delaware and not in New Jersey. Are you getting those benefits in New

Jersey in terms of outage restoration, outage detection, even without the AMI, or are there additional other benefits that you need the AMI for -- that you're finding you need the AMI for?

MS. LEFKOWITZ: Yes, it is an interesting comparison to look at, and I'll just say that many people in the room are local or aware of the kind of reliability problems that we had that were weather related over the previous five or six years or even going back further in this area, and the company built up a lot of competency around a very curious skill set, which is how do you integrate a thousand mutual assistance crews? How do you dispatch to all of them? How do you manage a far, far larger workforce during a restoration effort? So, we've had a lot of experience with that, and it's a logistics issue. When we got AMI, we were able to -- the biggest benefit -- and it's not intuitive until you've lived through it -- is we've automated the throughput from the meter directly into our outage management system, so now we are not sending a truck to a place where we don't know there's an outage. In other words, almost a hundred percent of the time we're dispatching a truck, there is a known and certain problem as opposed to in the previous world you're sending them and you don't know if they're going to find the problem, because all you've is SCADA data, which is pretty high. So, it's a way of getting at nested outages and evaluating it. It's a really, really hard thing to quantify, right? It's very, very hard to quantify that.

And then we fast forward -- and, by the way, during the (inaudible), we didn't even have the technology fully integrated. In a manual way, we were able to cancel 3300 work orders in D.C. and Maryland during our restoration effort, which is a huge, huge win.

Fast forward to Super Storm Sandy. We don't have AMI in New Jersey. New Jersey was in our territory where it was most hard hit. We did the best restoration effort in the state of New Jersey compared to all the other utilities, in large part because our logistics were down. So, it was kind of an interesting problem, because we got a lot of kudos from people who understand the industry, not the customers who were out for four or five days as much but people who understand what it takes to restore massive outage.

My belief is we could have shaved at least hours off the restoration if we'd had AMI. You know, the restoration efforts always have a very noticeable trend, right? They start like this: You have a big drop-off where you're able to just restore our breaker level, and then you've got this tail where you've got smaller outages that take longer and longer to restore because you don't go to them first; you always try to get the largest number of customers back in the shortest period of time. AMI is a technology that helps us essentially clip the tail off of that, because you can simultaneously be working on those smaller outages while you're dispatching crews to handle the large outages. I haven't found anybody who's been able to help me figure out how to predict what that percentage would be where the hours or the numbers -- we just know it's a clipping, because we're able to work in both streams at the same time.

Also, there's a great opportunity for vendors in the outage management space, whether it's an outage management system or work management dispatch system, which is to come up with smarter and better algorithms around using the data. We pushed our vendor early on to integrate, actually, the bit processing into the outage management system, and they have done that, but there is, I think, still a tremendous opportunity to improve even further, and I'm continually telling vendors the company that solves this problem or begins solving the problem -- because it will be probably be evolutionary -- is the business that's going to get my business, right? I don't have vendor loyalty; I have customer loyalty. I've got to do what's best for them.

CHAIRMAN COWART: All right, thank you.

Tim?

MR. MOUNT: So, I also have a question for Karen. It's nice to hear that you have some projects that actually led to tangible cost reductions for customers. I'm thinking of the example you gave with voltage reductions, that they cannot detect -- I mean, doesn't inconvenience them. What actually happens to those savings? Do you share them with customers? Are you under sort of performance- based regulation? Can you talk a little bit about that?

MS. LEFKOWITZ: Sure. So, on the CVR, those savings are -- think about it as a voided cost to the customer so they're not spending the money. And so we would call that a savings to them, but they've never spent the money, because they never used the energy. The same would be true of anything that's a demand response program. So, the money that they're saving is generally, at minimum, the energy they're not consuming and therefore not paying for, and in addition they may get incentive dollars.

Now, on the operating efficiency side, the way that we set up our program is -- and the simplest example is manual meter reading. We actually demonstrated in the other jurisdictions how we decreased our operating expense for that dollar value, for whatever that jurisdiction's spend was on manual meter reading. And of course the problem is cost may be going down here but they may be going up here, so from a rate-making perspective, it may not be a tangible savings. The biggest savings, though, from AMI over the long run is the cumulative effect of providing either programs or information that drive consumers to consume less either directly or indirectly. So, CVR is sort of indirect; a demand response program would be more direct.

The cumulative impact of that on a company that operates in the PJM market where we've got monetized markets is that the price curve has shifted down, so we're talking about changing the pricing on the generation side for these services, and then, again, it becomes an economic study to determine what amount of that price shift can you attribute to changing the gas versus cold change that we see in the industry versus the actual change in demand from the customers. And, you know, economists can measure that and study it, and we've seen a substantial shift in that cost curve.

MR. MILLER: If I can answer that from a co-op perspective, we see savings of between 1 and 4 percent energy when we do CVR on a rural feeder. Because we're not- for-profit, the cost reduction is directly into a situation. We have a simpler case than you do. (Laughter)

MS. LEFKOWITZ: Yes, much. You know, I should add, though, on the demand response programs that we're running, absent resolution of FERC 745, we receive funding -- we bid our demand reductions into the PJA market. We get payment for that. In all of our jurisdictions, our obligation is to give a hundred percent of that money back to the customer. So, we give that money back through incentive payments, and then there's some kind of true-up mechanism, depending on -- it's varies by jurisdiction, but in Maryland, for example, we true it up on an annual basis through the surcharge they have for the Empower Maryland Program, which is an energy efficiency that the state runs.

CHAIRMAN COWART: David? I think you're next.

MR. TILL: Fascinating panel. A comment for David and a question for Vickie.

First of all, David, I'm proud to be served by your smart grid, and when I can afford a house of the 21st century I'll look forward to participating more fully in what you do going forward.

I was fascinated to read in the paper about that smart grid detecting a fire next to a home that was the homeowner's responsibility and ya'll reporting that to the homeowner and authorities, I believe, and you might want to expound on that more in a moment.

Vickie, a question for you is -- you

mentioned that the greatest need for improvement in models is in the load models, and my question is: Are you speaking of specific large loads that need better models? Are you speaking of the -- I had the word a minute ago -- aggregation -- the aggregation of smaller loads that would beg for utilities to reinstitute their load research departments?

MS. VANZANDT: More the latter, I think. It all has a cumulative effect, so differences in home styles with vaulted ceilings instead of square footage -- it's cubic feet that need to be air-conditioned, so all of that -- and the characteristic of the load, not just the megawatts but the characteristic of the load is what's important. So, I think that just needs a fair amount of attention.

MR. MILLER: We are doing analytics as well, and, Vickie, I endorse your issue about load modeling. But our principal problem right now is to take power-flow models -- either open DSS or grid lot D -- and being able to calibrate them to meters. I mean, people are running these models for planning purposes, but neither one auto-calibrates to interval reading for meters. So, we still have -- we think that's utterly critical or we can't trust the results. We're working on the PNNL now but it isn't solved. But we think it's critical, so.

MS. VANZANDT: I'd like to add one more thing. The generator modeling -- recalling that NERC had studied the 18 months' worth of the last disturbances that were more than insignificant and determined some causes or some factors that contributed to that outage. And, overwhelmingly, the number one factor was generators doing something unexpected -- actions. Generator models -- we don't simulate their turbine controls at all, so that's a missing element in the power system modeling. So, that needs some attention. We're vastly improving the dynamic performance, but if the turbine controls take the unit off, and that was anticipated or expected, then maybe our limits aren't quite right either.

MR. MILLER: That brings to mind another area we see as a deficiency when you talk generators going back upstream from generators to the boilers. We do not believe the current generation of models for looking at the effects on boiler deterioration due to more frequent cycling is adequate. We have computational fluid dynamics to look at the way the boilers operate. We have finite element analysis to look at the structures of the boilers. But nobody has yet integrated the two so that we can tell how the life of a boiler is impacted by changing its cycling. Those models are not accurate, and they move staggering amounts of money, because the value of the boiler infrastructure is immense. NETL is working on it now, but it's at least a year away from having anything we can test.

CHAIRMAN COWART: Paul?

MR. CENTOLELLA: So, given that you've got -- each of you have done some remarkable work based on ARRA funds, and you talked about the motivational aspects of those funds. I'd like to sort of refer back. I don't know whether any of you were in the room yesterday, but we had a panel on great modernization, and one of the takeaways from that was the difficulty of moving new technologies that have passed proof of concept into actually being accepted into utility systems. And I'd like to get your thoughts about what can be done to take technologies that are not going to have $4.5 billion behind them to move into the marketplace and create a stronger pathway for innovations to actually move into the utility systems, and are there things that this group could recommend to DOE that would help facilitate that movement.

MS. LEFKOWITZ: So, are we talking about -- because I wasn't here yesterday -- are we talking about, like, a small startup company that has some new innovative technology?

MR. CENTOLELLA: I can give you a specific example. One of -- oh, I guess Tim's left. Tim Heidel was here and talked about this, and one of the companies in his portfolio was a company that does voltage equalization on the secondary distribution circuits and can get -- you know, instead of the percent and a half that you're getting in CVR you could actually get 5 to 7 percent reductions in generation requirements by doing that. And I think Craig's co-ops have some demonstrations on that. But it's a company that has a few demonstrations out there and is looking to how to break into the commercial marketplace. How do you make something like that happen?

MS. LEFKOWITZ: So, utilities are or at least the IOUs are generally risk averse, and the reason they're risk averse is because of the regulatory obligations and the regulatory model that we operate in. So, you know, I can remember a case in New Jersey -- and I hope none of my New Jersey regulators are here -- where it didn't affect us, but another utility had done a pilot to try something out and they put a bunch of money and people behind it. And after a couple of years they'd go in for recovery and the commission just said no, you can't recover it. So, if you don't think you're going to be able to recover the money, and there is no incentive for a utility to invest in something that they cannot recover from, so it creates -- it reinforces this idea that we don't take risks.

One of the risks associated with new technology is a small company, single brain trust, you know, two guys that are really, really smart working on something but it's not a marketable product that has a company behind it to manage its evolution and it's development over time. So, one of the things -- and I'll just give you a very simple example -- there was a company called Gridient that we thought was really smart. We thought that their visualization and modeling was about the best we'd seen, and we also thought that they were good enough that they were going to get eaten up by somebody else. So, we ended up cutting a contract with them that was a relatively small dollar amount, and we weren't, like -- we didn't want to, on the front end, bet a lot internally, right? So, we paid them to get the product, and then they got purchased by LNG. Now they're owned by as company that's got some heft behind them. We have some confidence that they're going to be around for a long time. Now we're starting to invest in leveraging that initial buy in developing the product. I think it's really hard to -- I mean, I've got to maintain stuff that's put out on the grid forever. And if the company is not around to support me, it's hard for me to justify doing it. It has to be a really big upside to risk it.

MS. VANZANDT: I would underscore the necessity that whoever is deploying anything has to see what's in it for them, so the communication about that -- I'll give you an example of a real desire in the West to have an independent generator deploy an PMU. It's up in the middle British Columbia coastline, and so it was my job to make the cold call and say: Please put a PMU in your substation. And they said: What's a PMU, and why should I be wanting to do that? Well, as a generator they are required every five years to do their model validation. It's a NERC requirement. And typically they have to take it offline and run it through a bunch of tests and have some engineering out there. I said: You don't have to do that anymore; it will just let the natural bumps and wiggles on the system record your response, and that will be enough to validate your model. And they said: Well, where could I buy one of these then?

So, we've been able to explain the benefit to them personally to deploy infrastructure. And like I mentioned, the additional participants outside the grant spent their own money, and what they got in return was a common, wide- area view of the whole interconnection -- voltage, stability, modal analysis, all that sort of thing, flows on the transmission -- and they thought that was a benefit to them. So, they deployed PMUs in exchange for getting access to that wide-area view.

MR. MILLER: Paul, the general theory of

new technology penetrating a market is rooted in the research, but an economist called Robert Rose, who actually looked at the spread of diseases on the islands in the 1890s, concluded that diseases spread slowly when there aren't many infectors, and then they accelerate when there are a lot of infectors, and then they plateau when everybody's already sick. A simple of way of looking at it but, basically, demonstration is the only way to get it out there. We need to create infectors.

And I like working for co-ops, and even though she does really cool work and blows me away every time I hear her, I feel sorry for Karen that she doesn't have my job, okay? (Laughter) Sorry. Anyway, because co-ops -- we have 900+, so every circumstance you can think of. This type of circuit, this economy, this kind of growth, these kinds of loads -- you name it, we've got it somewhere, okay? So, in our community we can usually find somebody for whom this technology really looks like a good idea. And we are, in fact, demoing and testing the VAR control in Iowa.

Second, we don't have a lot of committees. You know, we sit around a pretty small table and make a decision, because we're a small organization. And, third, co-ops operate under seven principles, principle 6 of which is the co-ops cooperate. So, if something works somewhere, you're supposed to tell people about it.

So, we're small potatoes. I understand that. And we have very little co-ops -- utilities. But we provide an ideal laboratory for trying new things, for proving them out -- rapid decision-making, circumstances that are highly favorable, okay? Wonderful customer relations. Our customers love us for the most part. The only smart grid problems we had is somebody kept shooting the fiber that we were putting up in Louisiana, and we attempted to install smart meters in what I would call a creative agricultural area in a remote part of Hawaii. And for some reason we had some issues there.

(Laughter)

So, we can help. Not the demonstrations

that we need to move the PEPCOs of the world and the Southerns of the world but a place to get started on the really avant stuff.

CHAIRMAN COWART: Granger and then Carlos.

MR. MORGAN: Craig, you talked about conservation voltage reduction in long rural feeders. Do you want to say just a few more words technically about what you're doing?

MR. MILLER: Yes. We've come up with several approaches for doing CVR. Some of them are communications intensive, in which we do -- we put in a lot of voltage regulators, and we communicate back and forth to level the line out. But it turns out that a simpler approach is just to install capacitors. You install sufficient capacitance, because capacitors are really cheap, okay? So, you put in sufficient capacitance to get a relatively flat voltage drop where the lowest voltage on the entire line is at the first substation. Seriously. And then we boost from there and then we go down. Then we just need a simple wire or fiber to the first substation where we do our first adjustments. So, we've eliminated all of the communications. We've replaced most of the expensive voltage regulators, and we're just throwing in cheap commodity caps to flatten the line out. And if you recall the first automation that was done in 1913, the connection was from the generator to the first substation, and it was a hard wire. And we have recreated early 20th century technology, and it works. So.

MS. LEFKOWITZ: Yes, I would just emphasize that all of our technology solutions -- many of them play out differently if you're in dense areas in D.C. or Montgomery County versus an agricultural area in Southern Maryland or South Jersey. So, we have found that we have had to adapt to solutions based on the density of the load and the feeder build.

MR. COE: This question might be more for Vickie, but I was curious when she had all this (inaudible) in place.

Did you have kind of a cross-correlation against the renewables, you know, particularly on the (inaudible)? What did that look like regarding stability and all that good stuff?

MS. VANZANDT: Yep, yep we did. So, I failed to answer one question that I was supposed to, and that is: Would this infrastructure be in place without the ARRA funding? And the answer is: Absolutely not. I think probably we deployed, between the participants and the additional folks outside the grant, over 600 PMUs, and I think it would have taken 20 years to get to that level of instrumentation without the grant, so -- and a very compressed time schedule to get it installed. So, that was all very good.

Part of -- particularly in the Northwest, Bonneville's Balancing Authority has 5,000 megawatts of wind, and it's all pretty concentrated geographically, and the instrumentation or the visibility of the wind farms there was not very good. So, part of this grant deployed visibility at the collector stations for the wind. And one of the purposes of that -- because there wasn't very good visibility and because the ramps were so extreme, that Balancing Authority carried, likely, more reserves than they needed to, because they just didn't know. So, having a peek into what they're actually producing in addition to good wind forecasting has been able to pare down that amount of reserves that are being required to be carried. So, yes, it did have an impact on wind integration.

MS. LEFKOWITZ: So, I just want to add one thing, Hank. It's something that David said that I think is really just a fundamental problem that we have.

Our customers don't appreciate us, and I don't mean that because my feelings are hurt, right? It's not that, although occasionally they are. It's that they absolutely do not value, in the tangible way, what we do. And because customers don't value it, that will influence regulators at both the distribution level and the transmission level. One of my colleagues says always: Electricity is what stands between us and the lack of civilization. Right? And it sounds very dramatic, but it's absolutely true, and yet customers are willing to pay two or three times what they pay for electricity for entertainment, cable TV, Internet, telephone and complain that their electricity bill is too high. So, I know I'm not going to change everybody's mind, but if you folks sitting in the room can solve one thing for us, all right -- it's increased, in peoples' minds, the value of electricity, because everything else -- I mean, we should be regulated. We are a monopoly. At least I represent a monopoly. We should be regulated. But we know that our regulators have an average tenure of three years on the distribution side. They don't necessarily understand the industry, and they are subject to the pressures that their constituents, which are the consumers, bring to them. So, it's very hard for them to withstand the pressure of saying: You're not allowed to earn more money, and everything that you're spending on could be --

somebody else could do something better with that money. Really? Really? Better than having electric power continuously at your beck and call? That magic, when we flip a switch the lights come on and some generator somewhere is ramping up, and millions of things are happening automatically? Better than that? Like, what's better than that? (Laughter)

So, anyway, I just put that out there, because it would be really useful if we could get people to understand the value of what we do.

CHAIRMAN COWART: Anjan, you're next.

MR. BOSE: A question for Vickie -- actually, two related questions.

On the PMU applications, many of the things that you've shown were more to better the reliability of the grid. Did you do calculations in the West about how much money is being saved because of the deployment of PMUs? And the related question is: Whenever I talk to the people who did the SGIGs for the distribution or PMI, they always seem to have to go to the Public

Utility Commission to justify their part of the cost of this. Did any of the people, like Southern California or PG&E have to do the same thing for PMU deployment?

MS. VANZANDT: Well, I can't speak for those utilities, whether they went -- actually, all of the utilities deployed their own PMUs at their cost, and the Smart Grid Grant money was spent for the integration and the communication and the advanced applications. So, I can't speak to whether the utilities had -- of course they would have had to get relief from their commissions for that deployment, but that was their case to make.

We did do some benefit analysis related to taking a generator offline to do its model validation -- old version versus new version where you just leave it online and gather information over the year to do that. So we used a case study of the nuclear plan in the tri-cities, and it was depending on the outage avoidance time. It was between $700,000 and, you know, enormous money.

So, that's really the only cost that we've quantified.

I think when the cost of reserves savings can be quantified after a period of time, that would be another one to do a case study on. We did not ask for specific permission or authorization to go forward with synchrophasors, nor did we ask for specific authorization for our distribution automation, the sectionalizing reclosure technology. So, we treated that as normal distribution expansion, and the transmission work was run through PJM.

CHAIRMAN COWART: All right.

MR. KENCHINGTON: Okay, can I --

CHAIRMAN COWART: Do you have a concluding comment?

MR. KENCHINGTON: Yes, just some concluding comments.

Just two things. One, Craig, on the cybersecurity it's really great when a plan comes together. Thank you. Just a little background there. I don't know if you recall back in, I guess, 2009 there weren't any really proven methodologies or standards on how to deploy these things securely. So, across the government, there was, with the phones ringing, right? -- DHS is calling, FERC is calling, and the Congress is calling and the White House is calling and saying: Are you really going to fight all this funding to deploy these smart meters and all these standards?

So, what I did was, just to give you a little story, I called together a team. I brought in all those parties -- DHS, FERC, CIA, NIST -- had them in the room, and I said: This is the biggest opportunity we have to improve cybersecurity across the sector. I thought they were going to fall off the chair, because they're all, like: Oh, my God, this is not going to work. So, I'm really glad to hear that.

MR. MILLER: Hank, when we started working on it with our approach, we briefed you. I didn't know you were on the telephone, and I was holding my breath, because it was an unconventional approach, and you said: Great, keep going, go farther, go faster. And it's been fabulous. I think this grant measurably -- this program measurably changed the cybersecurity posture of the electric (inaudible) industry in the United States.

MR. KENCHINGTON: Great.

MR. MILLER: And globally. It's a huge success, and in the blizzard of all the stuff that we installed, that can't be lost. That was one of the successes.

MR. KENCHINGTON: And the second comment is I want to thank all of you for the last five years. It's been a fun ride. Thank you very much.

(Applause)

CHAIRMAN COWART: Thanks to you all. It's a terrific panel. I appreciate it.

I have an announcement before we turn to our last two items, I think, and that is that we've been sending around a work product sign-in sheet, and if anybody didn't see it yet or have the chance to sign up for the projects that are underway, please come up here and sign it at some point before you leave today. I think it's gotten around, but it may be that it missed somebody.

We have a couple of subcommittee reports, and at the conclusion of this meeting we have the opportunity for members of the public who have signed up to address the committee. So, let me ask at this time: Are there any members of the public present who wish to address the committee today? I see none. Okay, so it may be that our meeting will conclude a little bit early.

So, David, are you ready to discuss the subcommittee?

MR. TILL: I am ready, and I thank you. I can't say enough about how wonderful that last panel was and how grateful I personally am for DOE's appropriation of that ARRA money for that particular purpose. And Karen asked: What can be better? The only thing that I can think of that can be better is "more." And that's where we're headed with this VAR paper -- is addressing an issue that can disrupt that "more." Every grid issue that gets solved produces eventually, I believe, another issue that needs to be solved that is more complex, more sophisticated, takes a lot more thinking, entertains engineers, aggravates financial people. But it keeps getting better. In my 35 years in the industry, it's just gotten better.

You have in your material for this meeting an outline of the value of a VAR paper, and Carl has done so much work and excellent work on it. And he has filled out some of that paper, because in addition to providing a status this afternoon, or barely morning, I want to give you an opportunity to avail of that paper that has gone around for the value of a VAR paper. If you haven't signed up to assist, we're going to ask for some more authors.

And one of the things that I want to do with this report is to provide a historical and a human context associated with that paper in the interest of supplying a little bit more even than Carl has.

If you look at the grid from the very beginning, there was a solution in search of a problem associated with the grid. As generally municipalities would set up power plants and start to electrify the town, there was voltage support represented within their local generator. And their local generator had a feature that they didn't particularly think about. It could supply not only steady state VARs to provide voltage support that was needed for problems on the system, that there was plenty of time to today, say, switch a capacitor in, switch some device in to respond to and solve it. But these generators also had within them and in their rotational inertia a response for providing quickly acting dynamic VARs. And they didn't think about it then, because it was a solution in search of a problem. We didn't really need dynamic VARs at the time.

But as the system developed and as transmission came more into being, as it became more of a skeletal grid, then there was need for remote voltage support but it was generally supplied in large measures by synchronous condensers. And those synchronous condensers applied because capacitors were not reliable and could not be built in the large magnitudes of support that were needed in the day. They were dynamic also, so you had a system rich in dynamic support and still no particular need for that dynamic support.

And then capacitors -- as the grid grew capacitors became reliable, became so much more cheap than synchronous condensers. They didn't have the issues with maintenance. They didn't have as much initial cost. They cost less to operate, because their losses were significantly less. And so we have grown, over time, from a system that was rich in something -- that we paid no attention to dynamic VARS that weren't needed -- into a system where we're starting to discover the problems that require the dynamic VARs in order to keep the reliability of the system.

But in the meantime, we've been pushing

toward being rich in steady-state voltage support that requires switching capacitors and other devices. And then we start retiring co-units, which were a big part of the injection of dynamic VARs under our system. And then we have fault-induced delayed voltage recovery problems, cascading voltage collapses in large megapolises with huge concentrations of air-conditioning. But we've got air problems in the area, so we don't want to burn coal in those areas, and we start to develop the dynamic that requires some engineers and financial people and other interested stakeholders, including the environmental people, to work together on setting up the voltage support for the future.

So, this paper has to do with that problem. And while we want to capture the general context of the grid that is producing the need, we also want to be specific enough to tell DOE to provide you with a recommendation where you can fulfill what we see as your greatest contribution, as Billy said yesterday, of the fundamental research and development to help us and to kick-start us in being able to together solve this problem.

So, we want to be specific enough, have the papers say specific enough things to be able to support recommendations, and that gets us into this situation where we're going to be addressing -- there's a need for dynamic bars, there's a need for steady-state bars, there's a need to know how much of each we need. And we don't really have that answer to the sophisticated end that we need to have it today. Although I'll always take the opportunity to brag on how well we've done, we need to go further.

So, do we want to send that paper around again, or do you all just want to line up while I finish my comments?

(Laughter) Several years ago, TVA conducted a stability

Workshop and was happy that NARC joined us and made it a joint event. And in the back of my mind, what I wanted to have was the Woodstock of electric workshops. So, as I had pondered that, I was somewhat gratified to learn -- how many of you know Bob Dintelman, who used to head the predecessor to WEC? Bob Dintelman was one of our participants, one of our speakers, and he got to tell how he went on the Today Show and explained about the California collapse and explained that you shouldn't look for that to happen often. And I'm not sure he'd gotten clear of the NBC Studio -- it may have been the day after, but he got a call: "Bob, it's happened again." But Bob, at the time, had a rock band -- at the time of our workshop had a rock band called Stucco Dogs, so during the breaks we'd play the CD that he had with him, because we wanted this to be the Woodstock of workshops.

And as I circulated through there -- and we had a bunch of heavyweights -- Paul DeMello from the Northeast who branched off with other what I've heard referred to as Godlike ones to form their own company. Paul was in his 80s, and he traveled to speak, and half the people there came to see him, because he had taught them at different times. And I circled through this crowd, and I was constantly asking them: How are we doing? Is this meeting your needs and why, what need is it meeting? And to a person, they were quite complimentary of the workshop. They had different needs that were being met. But the one that stuck with me the most and is relevant for this status update is the young man from Southern Company, who, a very sincere and competent smart guy -- and I've always been impressed with Southern stability people -- looked at me and he started to tear up. And please listen to this, because is a powerful thing. With tears forming in his eyes -- never dropped down his cheek, mind you, just teared up, just the right amount -- he said: David, I'm just glad to be in a room full of people that know what I do for a living.

(Laughter) And that's part of the gap that this paper is driving to close. (Laughter)

At TVA, we have these people, too. When I was over at the Transmission Planning Department, I managed them, and I found that there was always a bit of a gap there -- sometimes a chasm, sometimes a smaller gap. But we're looking to close that gap where when these people warn us that we need to put something on the system -- and they don't always know what we need to put on the system but we've got this problem that needs to be solved -- that we know enough to communicate with them and not necessarily with all of the go-betweens that we use now to bridge those communication gaps, and on the one hand to appropriately challenge them, because if Marilyn Brown were here -- my son told me what he learned in her class: Dad, they approach things differently than engineers. We're presented a problem and we say our job is to solve it. The first thing that these policy people do is they're presented a problem and they ask: Is it really a problem, and we need to have that discussion with these very directed stability people. But we need to have the communications that when they're right we know more quickly that they're right. And we prepare the grid so that it keeps on chugging, keeps on chugging, keeps on making life better.

So, you have the outline. I've tried to entertain and give color to it. I'm going to stake out up here to stay out of the stampede (laughter) to the group that signs up to help. I was gratified yesterday that Mark Lauby, as we talked in a break, got excited and he's going to fill out a bunch of the stuff.

Thank you. Questions?

CHAIRMAN COWART: No, it's not a question. I just want to congratulate you on your sales talk and services. It came across a little bit like a sermon, which is pretty good.

MR. TILL: It was the only way I could follow that last group -- was to go southern preacher. (Laughter)

MR. ZICHELLA: It's like having Will Rogers as your committee chairman.

CHAIRMAN COWART: Thank you so much.

Merwin is not with us to deliver the next report from the Storage Subcommittee, but I believe Carlos is on tap, right? Oh, no. Thank you.

MR. SHELTON: I don't know how to follow the southern preacher, so I don't know what I'm going to do. (Laughter) I think -- I want to start with covering, real quick, what the plans are. So, we've covered already the distributed energy storage and electric grid white paper and we've discussed that, so I don't need to cover that. That's work product this year that we're doing jointly with the smart grid group. That's expected to be finished this year.

And before I go into the next item, I want to point out that starting next year we'll have the biannual program assessment, which we just completed in 2014. We'll have that coming up again.

But in between that time, we've identified, as a group, mainly coming with some suggestions from myself and others that there be an opportunity to look at the implications of a high penetration of energy storage on the overall grid system, and before I describe that any more, I want to say as a subcommittee -- you know, we're called Energy Storage as a subcommittee -- we're a formal subcommittee, and we do have other subcommittees that are broader in nature than energy storage. And when we say "energy storage," what comes to mind is technology. But I think what we are talking about with this study is hitting on the edge of what was discussed this morning, and the work that PNL is doing is that storage has a category of capabilities that it is beginning to lend to the system overall and that those capabilities themselves and the implications of those capabilities en masse haven't been studied very much. So, the idea of this paper is similar to what happened with the ideas of renewable penetration coming into this system. What would the implications be of various levels of renewables on the system?

I think we haven't done that in a pure way, and we haven't seen studies that have done that in a comprehensive pure way, focused on the characteristics and capabilities of storage. So, that's really, to frame what this proposed work is, that's what we're talking about. And, again, storage has been studied, and we will, as part of this study that we're proposing, include the penetration analysis done in relation to renewables, but we will focus on framing scenarios and sets of implications that could be drawn from those scenarios from various levels of penetration of storage. And, again, keep in mind, our subcommittee name is Energy Storage. I keep saying that, because of course the implications that come from high levels of penetration of storage could be similar implications that would come from high levels of penetration of other technologies or combinations of technologies in different applications. So, we're not trying to say storage exclusively, and of course we would include in the scenario analysis a mention of and consideration of a host of technologies all working collectively in an architecture like the ones we were hearing about this morning. So, we would necessarily keep that context of course.

But given that our focus is on energy storage and the white space perhaps around which DOE could continue the research, we're proposing this type of study. So, I think, you know, we're at the early stage of adoption of storage, but we're talking about hundreds of megawatts now. And to put a little more concrete example behind what we mean, you know, what we're talking about in terms of implications, you might have seen a similar graph like this for solar PV 10 years ago -- probably less than 10 years ago -- and now we have massive adoption of that coming our way, and we've heard that California now gets 5 percent of its energy from solar PV. So, that is a significant shift that can happen in a short time. We think we're on the cusp of that here. Many other folks do, and a lot of us on the committee have talked about this as a potential. So, we, with the paper talking about getting in front of it.

To give one example -- or two examples, California being one. The target for energy storage in California is 1300 megawatts of storage, and a lot of that is fast acting. Already over 250 megawatts have been selected through procurements under those targets in excess of the targets that were necessary in this timeframe. So, we're seeing this adoption come quickly.

The frequency regulation market of the state is around 250 megawatts. So, if we have 1300 megawatts of storage in the state, it would start to subsume -- the capabilities of that set of assets would subsume all of the ancillary services of the state. This is just one example. So, how will that interact with those markets? What would it mean to the stability of the system -- those implications? We'd like to point, study, and direct the implications of this technology evolution with this paper and hope to see that it would encourage DOD to take a look at it.

Another example is Texas where Encore

has proposed over a thousand megawatts of storage. You have similar implications in that state where you have critical peak pricing driving the price formation for the wholesale electricity market. If you see thousands of megawatts of storage introduced that can deal with the three-hour peak in that state, it completely changes those models as well. Not trying to be prescriptive about models or market structures but just trying to talk about the implication of a mass presence of storage, which is possible in a lot of scenarios and which is being modeled I the overall architecture analysis.

So, I just wanted to give those as a couple of examples, and I think these implications relate to many of the topics that we've talked about. I already mentioned the architecture. I think the PMU discussion really points to our knowledge, the speed of our knowledge, and then what do we actually want to do with that knowledge, and a lot of the capabilities of the inverter-based controls and storage relate back to that as well. So, it's quite relevant to a lot of the topics that were covered here.

So, these are some of the things similar to what I just mentioned that we had on the slides. So, I don't need to belabor these points, given that we're rounding out the day. But I would like to get feedback on what we're proposing. Without going point by point, you have seen the approach to this paper. So, with that and with the time that we have, I think I'd open it up for feedback and thoughts.

CHAIRMAN COWART: Comments or questions. Paul?

MR. SHELTON: Before we take that -- sorry -- the timeline is that we would finalize an outline in the next month or so and be able to talk meaningfully about it -- an outline that we've had feedback on -- and we would consider what Carlos has been doing with the expert interviews. We'd think about that approach for this as well.

CHAIRMAN COWART: Paul?

MR. CENTOLELLA: So, one of the things that I would encourage you to at least think about is -- you're looking at high penetrations of storage -- is to think functionally rather than technologically in terms of storage.

MR. SHELTON: Definitely.

MR. CENTOLELLA: So, I mean, some of us have talked about the fact that there is, for example, a potential study in California which suggests that if you just manage the dead bands in thermostats, in water heaters, and in refrigerators throughout the year there's potential for 9 gigawatts of storage in just the residential sector in California, and for 2,000 hours of the year there's as much as 20 gigawatts of potentially movable load that is, in effect, virtual storage. And that is something that potentially could happen much more quickly than the technological options in terms of changing the whole way in which the power system operates. So, if you broaden the definition to a functional rather than a technological definition, you end up thinking about this, I think, in potentially quite different ways.

MR. SHELTON: I think we would definitely define characteristics that would be present in storage that would be present in other technology forms, I guess. Include that in the analysis, if that makes sense.

CHAIRMAN COWART: Have you discussed, as part of this paper, the question of increased penetration of storage that would accelerate the drive for distributed energy customers, like PV customers, to either accelerate their move to PV or decide to disconnect from the grid altogether because they can connect their solar panels to advanced batteries?

MR. SHELTON: The discussions so far have been around the system as a whole and the implications that if you had an ever-present -- you know a storage that was present across the system, obviously in different scenarios that we can analyze, so we should talk about whether this should be a scenario.

But the idea is that it's the grid and what it means for the grid as a system, and what we have talked about would be the implication for reliability expectations on distributions systems, right? So, you could envision a very stable system with a lot of dynamic VAR control, to go back to the previous -- with a lot of frequency stability that would be driven by the power electronics capabilities if they were in the right sort of dynamic system architecture, right? So, that's the idea, I think, that we were coming from and how it would impact distributed resources. We had not thought about defection or anything like that at that point.

I'll let anybody else on the committee, if we've talked about that. I don't think we've covered --

CHAIRMAN COWART: Carl.

MR. ZICHELLA: The one thing I would add -- first of all, I want to agree with Paul. I think we did talk about looking at the attributes, characteristics you're trying to gain and being somewhat technology neutral in how you approach that. There's only so much of that you can do when there are trends unfolding right in front of you, like EVs for example, which even though we haven't, as Carlos said, got a lot of feedback from some of our experts on that topic. It is something that's happening in real time. There are attributes that can be captured, and their impacts on the system can be very significant. So, it is something I think we need to get our arms around. I don't think we've so far yet, on the committee, gotten that nailed as to how we would go about that. But that's a lingering question that is a gap in our analysis so far.

MR. SHELTON: I would add that the idea is to envision a world that perhaps we've been unwilling to allow ourselves to envision, to really understand its implications, right? I mean, it's similar to a high-penetration renewable analysis that would have been done 8 years ago.

CHAIRMAN COWART: Carlos.

MR. COE: And I think the market studies

that we've been looking at in the DES space, the scenario that you painted -- that's one of the key drivers that they show for the rapid growth of DES as storage associated with solar. So, it will be included in this white paper. In that, we'll just ask questions that will lead into scenario analysis of this paper.

MR. SHELTON: And we're not planning to do the work. We're planning to envision the work that hopefully we could encourage DOE to do.

CHAIRMAN COWART: Pat's happy to hear that we'll be asking her to do more. (Laughter)

Any further discussion on this point?

MR. SHELTON: So, an equal call for -- please don't stampede us to work on this one, but it would be nice to get broad perspectives, so if you're interested in it please put your name on the sheet.

CHAIRMAN COWART: The page is still here, and we're making progress.

MR. SHELTON: Okay, good.

CHAIRMAN COWART: Is there more from the

subcommittee?

MR. SHELTON: No, that's it. We just wanted to identify the work that we're doing. This is the outline that we've been talking about and the types of implications. And, again, it's focusing on -- you know, like the subtext here, "Promise and potential versus confusion and controversy" is probably a good way to characterize it. But this was Merwin's prepared material. I just did a higher- level frame of it here. If you want to look at it, it was sent around.

Okay.

CHAIRMAN COWART: Thank you. Thank you. Is there any further business to come before the committee today?

Anjan.

MR. BOSE: This refers back to the question that was raised by Bill Parks and his group yesterday as to looking at their plans and for some comments from EAC, and I was wondering -- I was just going to make a suggestion that the

Smart Grid Subcommittee had the work group on R&D, and maybe that's the group that should actually take a look at the documents that are coming out of that group and try to have some comments, whatever, that the EAC is appropriate to do.

CHAIRMAN COWART: Wanda, did you have a comment on that?

MS. REDER: Clark's trying to hide. Anjan, I think you're right. It needs a home, and smart grid is probably a reasonable place. We'll figure out how to get that done, but it's good feedback.

CHAIRMAN COWART: David.

MR. GELLINGS: Well, as one person who has been involved in the development of that paper, I can tell you the scope of it is very broad. It's much bigger than just smart grid, so, yes, in an operational sense, an administrative sense, somebody needs to take on organization of the committee's comments. But I'm hoping we're going to hear from many people across the committee.

CHAIRMAN COWART: I don't think he'll object to that.

MS. REDER: Not at all. Yes, in fact -- yes, I think a full EAC review and coordination amongst the committees to figure out ownership, we need to take it on like that probably.

CHAIRMAN COWART: Okay. Any further discussion? Samir.

MR. SUCCAR: Just really briefly, I want to make sure that everybody sees the dates for the next two meetings up on the screen right now, and make note of the fact that the presentations, the slide decks that have been shown over the last two days, will be circulated early next week with a confirmation of all the names that we have for the various working groups, so please watch for that email. It will be a long one, but it'll be an important one, and I'd appreciate your feedback and comments if we got anything wrong.

Thanks.

CHAIRMAN COWART: Before we conclude, are there any members of the public present who have signed up to address the committee? I see none. Therefore, we've concluded our business, and we can stand adjourned.

Thanks very much, everybody.

(Whereupon, at 12:25 p.m., the PROCEEDINGS were adjourned.)

* * * * *

CERTIFICATE OF NOTARY PUBLIC

COMMONWEALTH OF VIRGINIA

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

(Signature and Seal on File)

Notary Public, in and for the Commonwealth of Virginia

My Commission Expires: November 30, 2016

Notary Public Number 351998

Respectfully Submitted and Certified as Accurate,

Richard Cowart
Regulatory Assistance Project
Chair
DOE Electricity Advisory Committee

5/12/2015
Date

Irwin "Sonny" Popowsky
Pennsylvania Consumer Advocate
Vice-Chair
DOE Electricity Advisory Committee

5/12/2015
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David Meyer
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