UNITED STATES DEPARTMENT OF ENERGY

ELECTRICITY ADVISORY COMMITTEE MEETING

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P R O C E E D I N G S

CHAIRMAN COWART: If you would please take your seats. Thank you. I'll call the meeting of the Electricity Advisory Committee to order. And as the committee members know, each of these meetings is recorded and a transcript is made and posted. If there are members of the public present, they will have an opportunity to speak to the committee tomorrow afternoon, and they should sign up. There's a sign-up sheet for anyone who wishes to address the committee. Committee members should know that because a transcript is being made, they need to speak into the microphones, and your mic needs to be on when you're doing that.

Thanks as always to NRECA for providing this meeting space. We really appreciate it.

One of the topics for this meeting actually -- we'll go around in a minute and everybody will introduce him or herself -- it's to sort of give some updates about committee membership, and to acknowledge the service of

those who have served on the committee and will be leaving us, mostly due to term limits that are imposed on committee membership, but to acknowledge specifically the work of Barry Lawson, Mike Heyeck, Tom Sloan, and Ralph Masiello, who have all been really seriously contributing members of this committee in writing, reviewing, commenting, organizing over their tenures.

And so, I want specifically to recognize them along with three other departing members for whom this is not their last meeting because they actually already have left the committee. That is Val Jensen, Claire Moeller, and Phyllis Reha. So we've seen some turnover here, and there are also some new faces to introduce. And that when we go around, I'd really ask the new people to say a little bit more about themselves than just your name.

So then, the new members are Marilyn Brown, Pam Silberstein, Ramteen Sioshansi. All right. Thank you. And Roy Thilly. And welcome to you all.

I'll start the roundabout here. I'm Richard Cowart from the Regulatory Assistance Project.

MS. HOFFMAN: Pat Hoffman, Department of Energy.

MR. MEYER: David Meyer, Department of Energy.

MR. ROSENBAUM: Matt Rosenbaum, Department of Energy.

MR. PETERS: Chris Peters, Intergy.

MS. REDER: Wanda Reder, S&C Electric Company.

MS. SILBERSTEIN: NRECA. We like NRECA better than NRECA. New member to the committee and looking forward to working with you. Thank you.

MR. SHELTON: Chris Shelton, NES.

MR. SLOAN: Tom Sloan, Kansas House of Representatives.

MR. ROBERTI: Paul Roberti, Rhode Island Public Utilities Commission. Also somewhat of a new member. I missed the first and the last

meeting, but glad to be here. Thanks.

MR. SIOSHANSI: Ramteen Sionshansi, Ohio State University, and I'm a new member.

MR. TILL: David Till, Tennessee Valley Authority.

MS. WAGNER: Rebecca Wagner, Nevada Public Utilities Commission.

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

MR. BALL: Billy Ball, Southern Company.

MR. CENTOLELLA: Paul Centolella, Analysis Group.

MS. BLAIR: Linda Blair, ITC Holdings Corp.

MR. BOSE: Anjan Bose, Washington State University.

MR. BROWN: Merwin Brown, California Institute for Energy and Environment and the University of California.

MS. BROWN: Marilyn Brown. I'm professor of energy policy at the Georgia Institute of Technology. Thank you for getting

this right. I can't tell you how many signs and name tags I've had that say Georgia Tech University. No, no. Anyway, and I worked at Oak Ridge National Lab for about 22 years before coming here, where I manage the Efficiency Renewables and Electric Grid Program. I'm also on the board of the Tennessee Valley Authority Board of Directors.

MR. COE: Carlos Coe with Millennium Energy.

MR. HEYECK: Mike Heyeck, and I'm really glad to be here. Just one correction for Ramteen. It's the Ohio State University. And I'm formerly American Electric Power.

MR. HUDSON: I'm Paul Hudson with Stratus Energy Group.

MR. LAUBY:: I'm Mark Lauby, NERC.

MR. LAWSON: Barry Lawson, NRECA.

MR. MORGAN: Granger Morgan from Carnegie Mellon University.

MR. PEDERSON: Jim Pederson, Federal Energy Regulatory Commission.

MR. POPOWSKY: And I'm Sonny Popowsky, retired consumer advocate of Pennsylvania. And I'm the Vice Chairman of the EAC.

CHAIRMAN COWART: All right. We actually have a pretty full agenda for this set of meetings here, so I'm looking forward to seeing how we can squeeze everything in. As usual, we begin with comments from the Department, and Pat Hoffman leads us off.

MS. HOFFMAN: So, first of all, I'd like to just express my thanks and gratitude for everybody participating on the Advisory Committee. From DoE's perspective, we really appreciate and value your input. For the new members, I'd like this to be a fun committee where we actually go through topics that are very important and relevant to the industry, have a robust debate around it.

Part of this is continuing to bring and transparent conversations on issues. We can debate out the different issues, but look at opportunities in which DoE should engage. Also

engage with the whole Department, but the Federal family as we move forward on issues. So those are some of the just kind of philosophical basis for the Advisory Committee.

I enjoy the debates and the discussion because it really pulls out the challenges and the complexities around the electric industry, and where we need to go, and some of the challenges we have in moving forward. And it's not easy, but there's a lot of things going on and a lot of topics that we have to address, and I'd value everybody's input that they provide the Department.

I know that the committee finished, and I had to have some folks pull it up. I signed out a letter from the recommendations from the last committee meetings and some of the reports that you all provided. And so, I want to thank you for all your comments on that. We looked at the resiliency recommendations, and we've been meeting an activity, engaging with White House, looking at transformers. But also within the QER, you'll

hear a little bit later of how do we continue to push resiliency and some of their interdependencies. So there was some very good recommendations and discussions there.

With respect to the Energy Storage Report, of course we're required to produce an Energy Storage Report every year. Every year? Every other year. And so, that was very synergistic in providing a balance to the report that we did with -- I think it was a request by Senator Wyden -- on energy storage, knowing that that is a technology that has great opportunity as we move forward. And so it's something that we want to make sure that we continue to follow what the strengths or weaknesses are with respect to energy storage, and some of the market opportunities. So I think those were fantastic.

And I wanted to see if there was one other report that I wanted to bring up. Well, I'll think about the other report. I know there was one other thing I wanted to talk about specifically regarding the recommendations.

But in the Department of Energy, we're going to hear on the agenda the QER, a topic on energy efficiency and renewable energy on renewables integration and the challenges that they see from the wind developer side, from the renewables side. And so, I think that continues to encourage the discussion, the dialogue, as I would say the marketplace evolves and the generation mix evolves. And the United States recognizing that there are some definite needs there.

And with that, I think I'll just leave my comments to go as the sessions continue to go on. But once again, thank you all for participating. Thank you for your advice that you give the Department. And I look forward to a lively discussion.

So who's next? So with that, we're going to move to the first presentation?

CHAIRMAN COWART: Actually Kevin has got --

MR. LYNN: So I'm not Rosenbaum. I'm

Kevin Lynn from the Department of Energy, and I work within the Energy Efficiency and Renewable Energy office. And my position is a relatively one. It is relatively new. Basically from EERE's perspective, we've been working on sort of some of the grid integration efforts for a while from an office-by- office perspective. And Dr. Daniel Senarsis and the Secretary was interested in trying to bring all those activities together, and tried to make them a little bit more holistic.

So really I think the purpose of this presentation was, your group has been working with the Office of Electricity for a very long time and doing great work. And I think the purpose of this was for us to sort of come to the fore and show you sort of what some of our interests and thoughts were in this particular area and sort of come at it from our perspective.

So, I mean, I think one thing I'd like to say is I've been working really closely with both Pat and David Meyer quite a bit over the last few months as part of the Grid Tech Team, so I'm

going to have a few slides that start off that talk a little bit about sort of the overall DoE-wide effort for grid, and then sort of narrow it down some to talk more specifically about what sort of our interests and our sort of play is we feel like within the grid space within EERE.

And I should thank Dr. Achenbaum who was the chair of the Grid Tech Team for quite a while, and it's always great to see him.

So I know there's not a whole lot of time, so let me go ahead and get started. So this is, you know, a part of our daily vision, and this is, again, part of the Grid Tech Team vision. So this is the entire DoE-wide vision, one where we're trying to develop a grid that's cost-effective and reliable, clean and efficient. That's very important from EERE's perspective and many perspectives. Secure and resilient, accessible to new technologies, and empower customers with a variety of options. So this is sort of a broad vision that we've developed over the year or two that we've been working here on

the Grid Tech Team. And EERE is certainly right in behind that.

This is sort of a slide that I'm not going to go into a whole lot of detail in, but, you know, as David and I have been trying to work together with the Grid Tech Team more broadly trying to determine what are the real challenges, what does it mean? What are the attributes? What are the things that the grid has to do in order to be successful?

And, you know, based on looking some of the efforts that we've had and some of the efforts that we've been working with the DoE Strategic Plan and having workshops and such, you know, we've come up with these eight different attributes that we think are core to them, and I think, you know, having your input on that would be really helpful.

But, you know, over the years I think, you know, having it affordable, safe, and accessible is really important, you know, going back to the 1930s and then in the 1960s with some

of the reliability, you know, issues and challenges that came up trying to make it more reliable, and then with both the Clean Power Act -- excuse me -- Clean Air Act, and with REO in 1992 trying to make it more clean. A more secure system that came along with 9/11, trying to make it more resilient in 2005 with Katrina and Sandy, and then also trying to make it more flexible as we get more wind and solar coming on board.

So there are a lot of attributes that have come on, and we've seen some of those newer challenges. You know, we've tried to narrow those down to a few challenges, increasing this number of devices that we have to control so the uncertainty that comes from a variety of fuel sources and from, you know, putting variable generation, like wind and solar, on a system. Two-way power flow, and increasing grid instability do a lot to having some of these EERE or solar and wind devices without any inertia as part of the system.

So, you know, part of what we've been

trying to do is trying to see if we can develop a program where we can measure, analyze, predict, and control the grid in a better way that can support not only sort of a national effort, but also regional efforts as well and making sure that we come up with an R&D that meets both of those, a national and a region perspective.

So why is EERE interested in the grid? You know, obviously over the last few years, and it's kind of surprised me. I came from the solar industry starting in 1998, and solar was pretty much laughed at. Now today we're seeing quite a scale-up of all this. This is just a chart of wind and expansion over the last few years, and we can see the number of gigawatts, and wind has just really increased and solar is really following it. So a big piece for us is making sure that we can seamlessly integrate all these technologies in the grid in a safe, reliable, and cost-effective manner.

And we invest billions of dollars to try to get these technologies to make them

cost-effective. And now we can't use them as a result of making the grid more unsafe or unstable. So it's key for us to make sure these technologies, if people choose to use them, that they can be used in a safe way. So that's sort of our perspective.

So as part of, you know, EERE, we've tried to pull everyone together again. We have 10 offices. We've got Solar Office, we've got Wind Office, we've got Water Office, Geothermal. All of them sort of approaching the grid from their own perspectives. And part of the goal for me and for Dr. Danielson is try to, okay, let's herd all the cats and let's try to come up with a single unified plan.

So part of that plan had to do with looking at things from a variety of layers, you know. We have a Buildings Program. It's very active. The office director spent 30 years at PG&E. Has a lot of interesting ideas on building perspective. Also looking at the distribution and regional perspective.

But then on the left-hand side we also wanted to look at it from somewhat of a layer perspective, sort of the device and control layer, communications layer, control layer, and a market layer. So we tried to sort of take those two different slices approach and tried to pull those pieces together.

You know, we have quite a variety of things that we came up from, but if you look at it from a regional level, and we're looking at the system control layer, one of the things that we wanted to do is work with obviously the Office of Electricity in developing tools to incorporate some of the, you know, stochastic methods to try understand the variability of wind and solar technologies and better integrate them into the grid.

You know, if you looked at it from the distribution scale, we've been working for a long time in trying to make some of the solar inverters more compatible with the grid themselves, so making that be able to VAR support, voltage

control, being able to make sure that the systems stay online in a real way if there's contingencies that come on board. So trying to make sure that the inverters can communicate with utilities and basically can be supportive as opposed to be a negative to the system.

And then, with building technologies, you know, working to understand. So there's all these different devices that we think that can be integrated and can be used to support the grid, trying to understand what those characteristics, you know, whether it be a refrigerator or, you know, a hot water system. Understand how those devices can be characterized and then used to support and provide not only services for the building, but also services for the grid. So these are some of the examples both from a scale perspective and from a layer perspective how we've tried to address these particular issues.

So, you know, those are some of the challenges if we were trying to look across those different scales and trying to look at some of the

solutions. These are some of the solutions, at least from our narrow perspective, that we saw that were important for us. So, you know, being able to build cheaper and more affordable sensors on the building scale and making them be able to communicate them with the grid. You know, the meter energy storage, we see that as a key piece for us. Interoperability and forecasting, tools and approaches for grid planning and grid operations, mainly supporting OE's activities in that. And obviously, you know, with all the penetration of rooftop solar, start looking at some of the policies, markets, and business models just from a technical perspective to provide technical assistance to those that are interested. And we obviously are going to be working very closely with UPSA and OE. You know, across the board DoE is very interested in that particular area.

So, you know, what are we actually going to do? So some of the things that we're interested in and we've been talking in terms of

Fiscal Year '15 is being able to look at doing a flexibility analysis to be able to understand what some of the low cost ways to incorporate more flexibility. So if someone wanted to incorporate more renewables, how they could do it. From a Stochastic Unit commitment, we've been working with OE quite a bit and trying to work with others to try to make sure that we can understand sort of how these tools can incorporate variability of renewables better.

Forecasting savings, we've been doing a lot of forecasting and trying to understand, you know, are we getting the actual cost savings that we think we should be getting from forecasts, both wind and solar forecasts. Trying to understand what happens when you put a high penetration of solar and wind on a system, what happens if there's contingencies? So does that really impact the reliability of the system? So those are some of the things that we're trying to look at, too.

And, you know, we're in the process of, again, working with OE. We came up with an

INTEGRATE Project. We're looking at characterizing and communicating. We're coming up with communications protocols and trying to manage distributed assets at our new Energy Systems Integration Facility, which just opened in September 2013. And trying to figure out how we can follow up that solicitation in 2015 with sort of a 2.0 where we basically hopefully working with other utilities to understand that effort better.

So I think also we could be looking at, based on some of the efforts that we have, developing some key reference documents around systems and controls from the EERE perspective. You know, there's a lot of interest from behind the meter storage on distributed energy, and that should say "behind the meter storage." So in terms of trying to really understand what should we be looking at in terms of behind the meter storage because we have a number of different offices that are interested in that. And trying to work with the Office of Electricity to better understand our modeling efforts. We have a number

of people using different models for doing different things. Let's try to understand, like, what models we should be using for what specific things so we can actually be working together across our offices, both OE and within EERE.

So this is just a picture of our Energy Systems Integration Facility. Again, I mentioned that it was opened last year in September by the Secretary. It's a great opportunity. We're trying to do some of our integrated work there trying to show how you can basically work both with buildings, technologies, and distributed generation technologies in an integrated fashion within the building and actually demonstrate how they could integrate it with virtual distribution systems without necessarily putting all these technologies on the distribution system, but allowing regulators and others to see what the impacts of putting some of this stuff in a power hardware in the loop fashion so you can actually see what the impacts would be in this virtual environment instead of a step before actually

putting it out in the field.

So we feel like this is a really nice facility. This is National Renewable Energy Laboratory in Golden, Colorado. We feel like it's just getting started. We're just getting some projected started going just this year, and we're going to follow up with that in the following year.

But I didn't want to take up too much time here. I know there's only a few minutes, but I'd be happy to take questions if there's time for that.

CHAIRMAN COWART: Yes.

MS. HOFFMAN: I guess I just want to follow up on a couple of things. Number one -- you know, I have to have this closer or they yell at me. Lesson learned, have it closer or, yes, you get the look.

First of all, I'd like to thank Kevin for being here and want to let everybody know within the Department of Energy we are really pushing very hard on coordination and coordination

of our activity and such that we've been doing joint budget presentations to the Hill. Also just really talking from a holistic view of where the Department is heading and some of the different needs across the whole landscape. And that'll continue to feed in, of course, to the QER presentation.

So just a couple of other things. The Grid Tech Team did do a National Laboratory Capability Summit, I think back in May 2013, around May 2013. And what we're continuing to look at and evaluate is what capabilities should we continue to invest in with respect to the National Labs? How do we structure the labs to provide the best value and partnership with industry? So that's something that we want to continue to address.

We're also looking and utilizing the National Academy of Sciences to do advance grid modeling activities for us and looking at the foundations around mathematics and computational capabilities with respect to advance grid

modeling. So those are some of the other things that feed into the picture. But we're moving forward, and it's been a good discussion within the building, but definitely a lot of opportunities.

CHAIRMAN COWART: All right. So the veterans here already know the drill in terms of putting their tent cards up. And I try to call on people in order when I can figure it out. You all were really fast. I'll figure it out. Granger was first? So, Granger.

MR. MORGAN: Yeah, I was waving mine because you weren't looking this way. Kevin, to what extent are you limited to analysis on the technical side of integration of things for distribution systems, or are you doing some analysis of policy-related issues or regulatory issues? I mean, for example, most U.S. states have exclusive service territories that make it really hard for anybody but a traditional utility to run a micro grid. And yet, you know, that's an integral part of the sort of things you were

talking about.

MR. LYNN: So that's a great question. You know, I did mention I think on the bottom of one of these slides, and I won't go back to it, that we're definitely interested in market's policies and some of the business model aspects. You know, from the EERE's perspective this is very important, but it's important across the Department. EPSA is a relatively new organization within the Department of Energy that takes a lead on most of these issues. But we also work together very closely with them with the Office of Electricity as well.

You know, very recently we had a solicitation come out of the Solar Program called Solar Pathways, and I know this doesn't go straight to your micro grid question. But as you know, there's been a lot of issues around net metering. Net metering is being questioned and whether or not that is the right path to go. And one of those solicitations that was reviewed by the Office of Electricity came out just recently

to look at sort of that cost and benefit analysis for distributed generation on a regional basis.

Basically that's been opened and closed, and they're doing some reviews of that right now. But obviously it's very important for all of the offices within the Department of Energy.

CHAIRMAN COWART: Merwin?

MR. BROWN: Kevin, as Chairman of the Energy Storage Subcommittee, this year we're working on a biannual summary report review of energy storage done at DoE. And in the past I don't think we've included EERE, and we're talking about doing that this year. What would be your recommendation of how to approach your office in that area?

MR. LYNN: Yes. I think I've been on one of the calls. I won't say that I've definitely been a regular on the calls, but it's hard to be. There's so much good stuff going on, but it's hard to be a part of it all the time.

I think, you know, from our perspective obviously we're kind of focused on a specific area

behind the meter storage. There's a lot of interest in that, you know, especially on the solar side, but also from the buildings perspective. You know, I think even though this has been done a number of times, you know, looking at storage in a variety of different perspectives. But I think, you know, we would really like to come up with some kind of reference document that I mentioned above.

So before we actually go and do any kind of investment, we've kind of characterized the field as it stands both from an electrochemical perspective and thermal perspective. And we have a few other technologies like CSPE and pump storage hydro that are special to EERE.

But, yes, I think, you know, working with you all in the best way, I think that would be wonderful. I think one of the things we'd like to sort of target is we've tentatively targeted a workshop maybe toward the end of this Fiscal Year, so in September, so we can get all our ducks in a row. But I think it would be great just to talk

with your committee and make sure that we know all the work that you've done before we start down another path.

MR. BROWN: So you would be the contact?

MR. LYNN: Yes.

MR. BROWN: Okay, thank you.

CHAIRMAN COWART: I'm going to work up this side and then go to Carl and Paul. Michael?

MR. HEYECK: I'm Mike Heyeck. A very good presentation. Let me just state the obvious. You know the dumbest part of the grid, the black rotary phone, is distribution. And as distributed resources make distribution lines much more volatile, you have that problem to regulate and working with the industry on that would be great.

On the other side of that, interconnection standards, such that, you know, when a pump comes on, all that stuff doesn't drop off and creates greater volatility. Working through IEEE and some other standards to actually get inside that industry paradigm so that these changes can be made.

MR. LYNN: Yes. The interconnection one is very interesting. You know, it always makes me laugh when people say, oh, it's so crazy that all this distributed generation falls off and, you know, we spent -- not myself -- but for four years I think OE worked and a number of people worked on interconnection standard for 1547, and that was exactly what they wanted. And now we've come to the point where it's like, hey, now we've got a lot of stuff. Now, what are we going to do?

So I went to one of the 1547 meetings I think last year, and even there it was difficult with a lot of what I would say that people have been there for a while, like, hey, do we really want things to stay online? Do we really want them to provide voltage support? Those were still some kind of crazy things to some of the people on the Standards Board.

But I think we're getting there, and as you know, standards take a while to change. But I believe we're moving in the right direction on that.

MR. HEYECK: Just one follow-up comment. Any time someone says "interconnection standards," there's the political element barrier to entry and whatever. I really think we need to approach it from the technical side in order to get it ingrained in the industry and in the vendors that provide it. Thank you.

CHAIRMAN COWART: Paul?

MR. HUDSON: Kevin, John Adams is embedded in Pat's group back over there, and Jay was with us last year. I wonder what type of formal process there is for the organized markets to funnel information. They're seeing a lot of this stuff in real time in terms of the integration. And I'm ignorant as to the processes they have for providing information to DoE. I'm curious about that.

MR. LYNN: That is a great question. I wish there was a more formal process to get information. I mean, we have requests for information that we put out. We do have workshops that we put out especially with the net metering

issue. I mean, there's so much stuff that's going on in terms of the markets. I mean, it would be hard for anybody to go out and sort of comprehensively go out and understand what's happening in Minnesota, and California, and Arizona, and all these different places.

We do do our best to try to get all that information, but I'd be open to any kind of suggestions that anyone has.

MR. HUDSON: I mean, just a follow-on comment to that, my experience with ERCOT at least is that they tend to be a little resource strapped, and if they don't have to comment on something, they may not. So something to think about.

CHAIRMAN COWART: Carl?

MR. ZICHELLA: Actually my question is similar to Paul's. It seems like there's a lot of experience right now in integrating renewable energy resources and ever-growing amounts in the organized markets in particular, but also in parts of the country right now. RAP just did a report

recently that looked at sort of an overview of some of the integration studies.

It might be a good thing to think about having an ongoing update, too, as we get more experience. And we'll hear in our panel discussions later today what people are doing with regard to forecasting and other sorts of things that were part of the Grid Tech Team's recommendations, and, frankly, everyone's.

There seems to be a very clear list of things that are needed now for integrating large amounts of variable generation, and more of a need to really track on how well and reliably we do that, especially in light of Water 111D being implemented right now. WEC just announced an effort last week to start doing, if requested, reliability analyses for some of the state compliance plans.

I was at the WGA last week. There was a lot of talk about regional solutions to compliance. There's a great opportunity right now to sort of collect and synthesize and experience

what's working. And I think the Grid Tech Team has just done a fantastic job of identifying the right list of things. And our Subcommittee on the 21st Century Grid and the paper that we're working on, we're sort of absorbing a lot of that previous work that you all have done, and it's pretty outstanding.

But it seems to me right now there's technology. There is a policy markets, operations, and standards. And one thing when I heard you talking earlier, Kevin, it really sort of concerned me a little bit was that's in a different part of DoE, and sometimes we talk about the stuff. I think we want to have some coordination between and among the parts of DoE that are looking at different aspects of this as we pull it together.

I know that it's hard enough to keep the eye on the ball on things you're supposed to be doing in your own group. But this is really sort of an overarching need that we have, and we need to get all the parts together on it. And I think

we struggled with our group in trying to decide whether or not to recommend things that were policy or technology. How do you pull those pieces together? Personally I think you need to put them all on the table at once.

MR. LYNN: I'll speak for my own personal experience at least. You know, when people talk about policy or they talk about, you know, taking all the information that's been put together and sharing it with regions or different folks, a lot of times some of the people that are, you know -- there's a lot of interest in doing the next new thing, right? But there's been a lot of things that have been done that are really interesting and good, and getting that information out to people in a good or smart way.

Everybody recognizes it, but sometimes it's a little bit harder to fund because it's, like, it seems like it's just old work and you're just going out and telling a bunch of people. It would be helpful for, like, folks in this group if you feel like taking information that's been done

through some of these studies that we've done and sort of compiling it and doing workshops around that, if that's something of interest or you think that that is useful to, like, let people know, like Pat or, like, you know, my boss, Dr. Danielson.

Sometimes I've struggled a little bit. I don't know about you all's group within OE, but, like, within our group0, trying to make sure that we get all those lessons learned out in the best way possible is not always the next thing. I know that doesn't necessarily answer all the questions that you had.

But the other things was I would want to say in terms of the flexibility, and David and I have talked about this a good bit, in terms of regional flexibility analysis, trying to determine, like, what's the low-cost way to get flexibility on your system from a regional perspective. That's something that I'm excited about, and I hope people are excited about here as well. And if you are, it would be great to figure

out what's the best way to implement something like that.

CHAIRMAN COWART: So thanks for the presentation. There's lots of good stuff in there. One of the things that I wanted to raise was if you look at what's going on in some of the states today, and I'm thinking particularly New York, which I'm assuming you're following in all of this, is really beginning to push the envelope in a number of ways. And so, it's not anymore as though we have markets up here and we have devices down in here in a layer.

You know, we're looking at something that will require an integrated market design, an integrated information architecture, and an integrated control architecture, because they're talking about markets at a distribution level. And I'm wondering, you know, how that is shaping your thinking and how you see that going forward in being able to support those kinds of, you know, regulatory initiatives as well as the comparable things that are going on in California and

starting in other parts of the country.

MR. LYNN: Yes. It's interesting trying to draw and create a visual of something that's so integrated, right? So you break it into parts, but then, of course, you want to put it all back together in the same breath.

But I think, you know, in a short presentation, everybody at DoE understands the importance of being able to look across those layers that we have laid out. And a million different organizations look at the different layering systems. But we definitely reflect your comments looking across those layers as a key.

CHAIRMAN COWART: Chris?

MR. SHELTON: I think my comment and questions build on what Paul was just, I think, mentioning. And by the way, I appreciate the presentation. I really like the way that you've sort of stratified the different levels and that type of thinking. I'm encouraged to see that.

So have we thought about the regulatory environment and its variability across the U.S. to

be driving constraint as sort of a design input, where if we're thinking about the control layers or the information layers? I think, you know, similar to what Paul was saying, if we want a standard and we would like industry to coalesce around certain standards, informing those standards with the constraint of the regulatory variability that we have seems to be critical to the job.

It's an incredibly difficult job, but one, I think, you know, we should try to accomplish in these programs. But have you thought about it that way as a driving constraint so it becomes part of the scope as a constraint, not something that you're trying to change or influence, and perhaps in so doing, you may inadvertently influence different policy outcomes, but it wouldn't be the actual intention.

And then, also one additional question related to that. Have you thought about where you could have dividing lines in technology so that the meta information, that the information layers

could start to move forward and so we could start to get momentum around those. Anyone can adopt them in any regulatory environment around the country, and so we can start to get some movement.

MR. LYNN: So regulatory environment as a constraint. I guess I hadn't quite put it like that, but I think we definitely see a regional analysis. There's a national perspective, but all the different regions around the country are going to have different perspectives and different regulatory constraints, if you want to call it that. And I didn't really go into some of the things that we've developed recently on the Grid Tech Team, but trying to both develop something that's core that everybody can use from some perspective, and then it can be applied from that regional, however you want to say it, constraint or otherwise, is I think a kind of a core thing that we've been struggling and trying to find. It's like how do we do this right?

We know even when you look back, and David and I always talked about this. If you look

at that necklace diagram, we had eight different attributes. Some of those attributes also can be not necessarily constraints, but certain parts of the country may say, hey, resiliency is more important to me than, say, clean, or reliability, or affordability. And trying to tailor that set of attributes more toward a region also is something that we find. We have to develop a program where applies everything applies to everybody and then tailor it and let those regions use it the way that they see is best for them.

On the second piece, you know, in terms of standardization, within the Buildings Programs as an example, we have a great standardization effort where they look at, you know, doing building standards, load standards, and other things. There are some possibilities that we might be able to look at something similar on the grid side for something like that as well where you could have something national where these kind of standards could apply across the country.

Obviously DoE has got some limitations

around that, but there are things we can definitely do in that area.

CHAIRMAN COWART: Marilyn?

MS. BROWN: Following up on Granger Morgan's comment, and he's conveniently left his spot, but anyway, on energy policy, I'm wondering if there is a place within the Department of Energy, either EERE, Electricity, or EPSA, that is looking at some of those electricity policies that are so important to making distributed resources and demand resources a part of the solution.

We've seen a lot of work to date on the coupling, but there's an emerging debate raging about electricity price design and how to manage incorporation of a lot of distributed resources for which the utility companies don't receive any return on their fixed costs. So movement towards, say, discussions of straight fixed variable price design. And their implications of that for efficiency doesn't give us much of an incentive to the consumer to watch demand because they're paying mostly now for fixed costs.

So is there an analysis effort looking at all how all of that might play out in an either receptive or promising or otherwise difficult mode? Yes.

MR. LYNN: Rosy scenario, right? Yes. So David and I also have been working, well, relatively recently on sort of the costs and benefits of distributed resources. So focusing mainly on solar right now because it's sort of the big player in the room. But we want to look at all the distributed assets with our electric vehicles, you know, really trying to understand what are the costs to the system, so if there are fixed costs, like you mentioned, but are there values to those systems and, you know, how do you determine what those values are in a transparent way that everybody can look at and at least maybe not necessarily agree to, but they can say, here's how we've laid out what the costs and benefits of these distributed assets are.

And you can as a regulator, as a stakeholder in the process, you can take those

transparent inputs and use them as you see fit. But at least everybody can sort of lay it out on the table and understand, okay, well, this is definitely a cost, you know, and maybe you can look at it from a different perspective, because there are a million different perspectives that regulators and others are going to come to the table with.

But that's something that's sort of in the near term that we've been working on, and I think the solar pathways solicitation I mentioned does point to that. But we are trying to sort of move that ball forward slowly but surely.

MS. BROWN: Are you linking value of solar or renewables or demand side to rate design and what the consequences are?

MR. LYNN: Yeah. You know, personally I'm always a little hesitant to say and that means that your rate design should be X. But I think it's nice to be able to say what the values and costs are, and then people can apply rate design to that in a transparent way.

People will value things. It's up to people, the regulators and others, to actually put the rate or the costs that they see fit. But I think it is wise for DoE to be able to at least look across the Nation and provide sort of that technical assistance to show in different regions of the country and different areas and different situations what those costs and values might look like.

MR. MEYER: David Meyer. I appreciate the interest that people have expressed in the policy or institutional aspects of good modernization or accommodating new technologies. But Karen Wayland from EPSA will be here shortly to report on the QER, but it's important to understand that EPSA is the policy office within DoE reporting to the Secretary. And they're a new office, and their number one assignment right now is the Quadrennial Energy Review. But looking ahead, they will be very much involved in analysis of some of these questions related to business models, and valuation of emerging technologies,

and rate design issues. I know they are keenly interested in those.

I'll go back to the theme about the Secretary's insistence on offices working together, taking a very holistic view of things. So I expect that particularly post-QER we will be getting deeper into some of these issues working collectively -- OE, and EERE, and EPSA, and other parts of the Department as well.

MR. SLOAN: Tom Sloan, Kansas. And, David, I appreciate your comments. Something that you both know, you know, when you're putting out RFPs or information, most public utility commissions have staff that (inaudible) most utilities and RTOISOs do. Most legislators at the state level who define the criteria and the process that our commissions will use when setting rates or looking at things don't. We don't have a permanent staff, and most of us either are old and senile or have other jobs to maintain their families.

So as you're looking at this, and it's

something that Pat and David have heard me talking about before, keep in mind how you might best reach people like me or people more capable than me, because we're going to set the rules that our states will use. And that interaction between us and you is terribly important. Thank you.

CHAIRMAN COWART: Thanks, Tom. A really good point. Paul?

MR. CENTOLELLA: Paul Centolella. I just wanted to follow up on the conversation that Marilyn and Kevin had a moment ago. And, Kevin, you talked about transparent values for PV in a distributed sense. I think that, I guess, concerns me slightly in the sense that when I look at that where the value of PV varies tremendously depending on where it is on a grid, what it's displacing, how much of it there is on any particular feeder, et cetera.

I would hope that the Department would work closely on tools and models that would help regulators and utilities to figure out what the value is in their particular settings for their

particular installations rather than, you know, aiming towards a value or even a value or a state for a particular thing.

And so, I just hope that that's where you're headed, and I just wanted to clarify.

MR. LYNN: Definitely. I mean, yeah. I mean, everything you just said is really important: Developing tools, where you put it, what region of the country you put it in. But that's all right in line with what we're trying to develop.

MR. CENTOLELLA: Okay.

MR. MEYER: For us, one of the most important things here is to not be prescriptive -- David Meyer, Office of Electricity. When you think about the valuation question, we think about it in terms of trying to come up with or help the community, as it were, come up with analytic conventions for how to do this kind of valuation analysis. But we are not going to be in any way prescriptive about what we think the end results ought to be. We recognize that other people have

those responsibilities.

CHAIRMAN COWART: In addition, I take it that you're also saying, by agreeing with Paul's point, that even within a jurisdiction, even when there are values to be determined, that the Department will be pointing out that those values may vary from feeder to feeder or substation to substation.

MR. MEYER: Right.

CHAIRMAN COWART: Okay. Thank you. Mike?

MR. HEYECK: I'm a simple guy. I just wanted to -- this is Mike Heyeck. I'd like to bring back the point that if you think about the institutional roles, not just regulators, but the commercial sector that could develop. Right now if you need a hot water heater, you call a plumber. If you need HVAC, you called a HVAC specialist. If someone has puts in PV power, who's going to do that? Is it an electrician? Somebody is going to coalesce this into something commercial that would provide some value with

respect to efficiency.

And as we think about institutional pricing, it's not a regulator, but it's also enabling that commercial sector to package this because I do believe right now institutionally we're so fragmented and siloed that we could really coalesce into something in energy packaging rather than just putting in your hot water heater.

So I'd just encourage you to step back and look at the simple paradigms as we look at the esoteric.

MR. LYNN: Yes. I know that's been a factor for a lot of us. But, I mean, just like on the solar side, I know trying to sell live voltage support, you know, you have all these capabilities that, you know. You have this list of capabilities of things that you can do, but the question is who cares? Everyone wants to buy it, and so they all kind of go together in that, and I hear that all the time from those folks. So we have to figure that out. We have to work together on that.

CHAIRMAN COWART: Wanda?

MS. REDER: Yes. Good presentation. I was encouraged about NREL in the virtual lab. And following up a bit on Mike's comment where there's a lot of institutional practices and paradigms. And I think, you know, as we go through the grid, you know, the INTEGRATION initiative, it really challenges us on a lot of fronts. It doesn't matter if it's policy, technology, workforce development.

Can you comment a little bit about how the National Lab strategy might be used to help move the paradigms and kind of our traditional norms in order to get to this vision?

MR. LYNN: Sure. So I think right now the National Labs are doing a pretty good job working with some stakeholders across the country. There's a lot of expertise in the National Labs. There's a lot of National Labs that sort of have some similar kinds of capabilities.

So right now, I think a couple of things we'd like to do. One is, as Pat had mentioned,

last year we had asked all the labs to come together and say, hey, tell us what your grid capabilities are. What is it that you do at LBNL? What is it that you do at NREL? What do you at PNNL? What are those capabilities?

I think one of the things we want to be able to make sure that we know and can sort of characterize what some of their specialties are. I think another piece is we know who to go as opposed to, like, well, having a bunch of people develop very similar kinds of activities.

And, two, I think we'd like to have sort of a one- stop-shop for people like you and people like in this room. So instead of going to, you know, this lab and that lab to do kind of the same thing, you could go to one lab and sort of see the entire space within the laboratory space and be able to understand here's the whole host of capabilities that we have as a lab. And because you're really interested in power flow control, you can go to X lab because that's really what they do best, and you can talk to them.

But I think at the same time, there's an aspect not only of what their expertise is, but also just having them there, you know, reaching out regionally. And most of the people, you know, if you're in California, you know the labs that are in California. If you're in Colorado, XCEL knows NREL really well.

So being able to still contact them and have points of contact with the people that you see and know pretty well, but at the same time sort of have this integrated approach where you're getting the best and brightest from across all the lab complexes as opposed to just the people that maybe you see more often than not.

We're working actually quite a bit more detail on that, but that's sort of the broad perspective, I think.

CHAIRMAN COWART: Obviously this topic is of great interest to the committee. We're going to take a break now. But I would like to close this session by renewing the statement I made earlier, which is we're really glad to see

EERE in the room. And this conversation I think makes it plain to you that we understand that connecting across the two offices is extremely important. So thanks very much.

MR. LYNN: Yes, thanks for having me. Some other offices are going to be here, and having some other offices here I think is great. So thank you.

CHAIRMAN COWART: Thank you very much. We're taking a break until 2:20.

(Recess)

CHAIRMAN COWART: Please take your seats. I think I've got a new plan for our next meeting, which is that about 15 minutes before our break, we go tell the café that we're going to have a peak demand situation on the coffee.

Just before we begin the afternoon session, I noticed there are two people here who did not introduce themselves when we first went around the room. So, Clark?

MR. GELLINGS: I'm Clark Gellings, and I'm a fellow with the Electric Power Research

Institute.

MR. BROWN: Roy?

MR. THILLY: Roy Thilly. I guess independent. I serve on the NERC Board of Trustees.

CHAIRMAN COWART: Thanks very much. Did I miss anybody else?

(No response.)

CHAIRMAN COWART: All right. Thanks. So our next topic is discussion of the QER. And I notice that our announced speaker is not here, but instead we have able substitutes, Carl Pechman and Larry Mansueti from the EPSA. So I'm just going to turn it over to you two, and lead us through it, please.

MR. MANSUETI: Thanks, Rich. For those who don't know me, I'm Larry Mansueti. I'm from the Office of Electricity, Pat's shop. I'm detailed for about, I guess, a year to the EPSA, Energy Policy Systems Analysis Office, to help on the QER, particularly help with all the different public meetings. Geez, I think there's something

like 15 of them that are on their way between now and September-ish or so.

And I'm here to give you an update. Also Carl Pechman, I'm going to reserve half my time slot for him. He's also from QER Office team. He's the number two electricity person, part of the QER, and he actually some specific things he wants to talk to you about and actually ask for help on.

So with that, I'm going to give you an update. I think Karen Wayland, who unfortunately had an emergency with her pet, her dog, obviously sends regrets on not being here. And so, I just got the call about an hour ago, but luckily I have her talking points, so that always helps when you're substituting for someone.

Just to recap, the Quadrennial Energy Review of the Administration is this time -- this time meaning there will be future Quadrennial Energy Reviews done on an annual basis. This one is looking at the transmission, storage, and distribution of all forms of energy. That means

no generation or production and un-use. Those are our scope out of this particular this one. Those will be handled in future years in an order to be determined.

We've had three meetings so far, public input meetings, I should say. April 11th was one on the vulnerabilities of the entire energy infrastructure system, again, transmission and distribution of all forms of energy. For example, we had Jerry Colley representing NERC there speaking, and Joe Rigby from PHR, the local holding company, utility, was there describing some of their activities in that area. We also had a CL from a coop, G&T Arkansas Electric Cooperative speaking there.

Infrastructure constraints, that was in New England, two places at once in one day. In the morning it was in Providence, and then, since you're in New England you can get to one place pretty quickly. We were in Hartford in the afternoon.

Infrastructure constraints, the main one

is gas and electric obviously, though there were some problems during the polar vortex with coal deliveries and oil and barge deliveries and so forth. And the Gulf Coast, petroleum, transmission storage and distribution. That was held in New Orleans on May 27th. Our Energy Secretary chaired all three meetings.

This Thursday in San Francisco is a public input meeting on the energy and water nexus. John Holdrum of the White House's Office of Science and Technology and Policy will chair that one. Transcripts of all these meetings as well as links for those meetings for the video links that we've been able to do, the statements of all the panelists, and summaries of the meetings can be found on the QER website, which is energy.gov/QER. And for each meeting, we do have a briefing memo, background memo, that may or may not be of interest to you. And it includes at the end of it some key questions, and challenges, and opportunities that we think are out there and also form the basis of some of the panel discussions as

well.

Upcoming meetings you may be interested in. We have two electricity-focused hearings, one Eastern Interconnection, one Western Interconnection. The one in the east will be in New Jersey. There's no date on that one yet. July 11th is one in Portland, Oregon handling the Western issues.

There is one in Wyoming for infrastructure siting. Again, infrastructure -- oil, gas, all kinds of energy, electricity transmission obviously. Gas, electric energy independence in Denver, rural electricity issues in Iowa, and finance and marketing incentives in New York City. There are others as well as gas TS&D. None of these have any dates yet, but, you know, subject to scheduling of or Secretary or other officials, then we do announce states.

A couple of things that have happened at these meetings that we have heard from I want go over before I turn it over to Carl. Some of these things probably are not that surprising. In the

scheme of things, what we've been hearing about, at least in the electricity business, is that utilities still do a good job of providing high-quality and reliable service. They are deploying technologies as they can and updating their facilities.

We saw -- actually this a shot out to Pat Hoffman -- at the Vulnerabilities Meeting, the utility industry themselves was very effusive about the Administration and DoE's role in Sandy recovery. So they really liked that work. And there seemed to be a coalescing of working together between government and industry in disaster recovery, resiliency, and so forth.

Writ large, you heard in each of those first three first meetings, there are issues arising, as you can expect, from the changing resource mix we have in this country, whether we have an oil and gas boom or changes in generation, you know, electricity, that are looming or already have occurred, and the challenges, whether it's reliability, costs, environment that are occurring

from that.

In these particular meetings, we haven't touched on the major electricity subjects so far. So we did hear a lot about redundancy and cybersecurity, physical security. That was a lot of the subject of the first one. Let's see. What else came up?

Oh, one thing with New England, New England, as you probably know, has had issues with gas/electric energy dependency for a number of years. We did hear and see the region starting to get their arms together around the issue, starting to come together not just from a technical standpoint, but from a political standpoint on coming up with some solutions to fix their issues.

During the New Orleans meeting, we did hear that was petroleum TS&D. We did hear a port official noting the importance of electricity infrastructure and how he feels that's a weakness that could be improved in the port system. And then a pipeline executive. I think it was Colonial Pipeline that ships product up here along

the East Coast, noting his view that the biggest exposure through reliable operation of his pipeline is electricity. And so, many of them were talking about the need to harden the electric infrastructure, not just along the various pipelines that come out of the Gulf, but also right down there were all the petroleum processing and pipelines are at.

One item that we're struggling with -- we think some of the answers are within us -- is we'd like to have more stakeholders, more input physically at these hearings after we have these panelists talk -- "talk" means a couple minutes of opening remarks and then panel discussions. We're not getting that many folks coming up to the microphone to give public comments. We'd like to get more.

We do know that part of it is we often were jammed with having meetings scheduled at the last minute, so we didn't get our agendas up on our website until maybe three or four days beforehand. So how do you know if you want to go

if you don't what the agenda is? But we're trying to improve that, and now we're getting more advanced notice on our meetings.

So with that, how about if we have any questions we hold off until Carl talks? Carl?

MR. PECHMAN: Okay. Thank you. I don't think I have to tell this group one of the basic premises of the electric portion of the QER that electricity is really at an inflection point. The industry that we've known in the past is changing rapidly. There are many forces from greenhouse, the need to reduce greenhouse gases, the introduction of renewable energy generation, much of which is intermittent, the increasing transactive role of customers, the digitization of society and of the electric industry, and the requirement to maintain a higher standard of reliability with respect to the electricity, combined with issues of resilience.

A lot is changing, a lot will change. We view the transmission and distribution system as the platform over which much of this will

change. The platform both in terms of the business models, the market structures, and also the physical nature of the system.

The electric portion of the QER will hopefully provide a roadmap from where we are now to some future state. And I'd like to -- and there are many issues. I think I have a list of 20 major issues, some of which are physical, and cybersecurity is lumped in as the single issue, or maintaining resilience is a single issue. These are all major. They're huge. They require a lot of input. They require a lot of thinking and thought and analysis.

And where we're starting or where we're trying to start is where are we now. What is the state of the system? And as we've looked out, we've had difficulty, in fact, trying to get our hands around what the current state of the system is. EPRI has been very helpful, and we continue to work with them. And as Larry indicated, we're interested in your input as well on ways of thinking about the state of the system as it is

now. But not only the state of the system as it is now, but where is it that we're going.

So we're in the process of engaging one of the National Labs to create a future grid architecture, not a finalized grid architecture, and certainly not a plan for how each of the different markets are going to operate, but a way of thinking about a framework for thinking about the future so that we can better track our movement from our current state into the future state.

And it would be terrific. One of things that you've probably recognized about the QER is that there's a huge amount to do in less time than we would like to have to get it done. And so, this summer is going to be a push huge. We're looking about a 10-week period to have a preliminary grid architecture that we're trying to develop. And we are in that process going to have several public meetings, stakeholders meetings, with the contractor, with the National Lab. And we invite your input in those meetings. And if

you let me know or let Larry know of your interest, we'll certainly make sure that you're aware of what's going on.

I think it's a very exciting project. We have to keep it focused. We're trying to handle a whole variety of issues from the transactive roles of customers to information protocols, but at a level where we can try to get the policy blend. How is the system going to be paying for itself? How does it support alternative business models? How does it maintain resiliency? Things of that sort. So it's a very challenging and exciting project, just one of many that we're involved in, and look forward to your good thoughts and suggestions and input. And I thank you for your time.

So with that, I think we open it up to questions?

MR. MANSUETI: Right.

CHAIRMAN COWART: Just for starters so you know, I think the members of this committee are extremely interested in providing concrete

assistance to the QER, and we'll be better able to do that if we're alerted to specific topics on which the expertise of the members of the committee would be, you know, relevant and could be provided.

MR. PECHMAN: We have a working list of issues that I would be happy to share with you. And, you know, to the extent that individuals on this committee are interested in particular issues, I'd be happy to engage and receive their input on those issues.

You know, again, it's a balancing act. It's a juggling from here until the completion of this. And so, but we'll do our best to engage you and to bring you into the process and to work with you.

CHAIRMAN COWART: All right.

MR. PECHMAN: And look forward to it, in fact. I'm very excited about getting to know more of you and having your insights reflected in the report.

CHAIRMAN COWART: Right. There are some

work products under way within the subcommittees that I think would be of significant interest to your team. And we're just looking for the right way to open the door and hand in those ideas.

MR. PECHMAN: Well, we can talk about that, you know, and again, we're very excited to have your input.

CHAIRMAN COWART: All right. Thanks very much. I already see some cards up. I'll start this time on that side. Carl?

MR. ZICHELLA: Thank you, Carl. One of the things, bouncing off what was just said by Richard -- Carl to Carl -- one of our products is recommendations for a 21st century grid, modernizing and updating the grid. Obviously exactly the same framework that we're talking about in the QER. We produced an outline of that. I'm pleased to hear much of what you said is reflected in that outline.

But one of the things we'd like to do to kick off this very welcome collaboration that you've just offered is to share that with you and

get some feedback to see if we're overlooking things that we ought to be considering as part of that, or if maybe we're seeding some things in our paper that you have not added to your list of 20 or more issues.

So I just wanted to make you aware of that.

MR. PECHMAN: That would be terrific. Yes, great.

MR. ZICHELLA: It's just an outline at this point. We're drafting portions of it right now. In fact, after this meeting we have a panel following yours that's sort of kicking off our drafting process. We're hoping to be able to pull all this together in time for our September-ish timeline.

MR. PECHMAN: I've love to be able to stay for that.

MR. ZICHELLA: Great. Thank you.

CHAIRMAN COWART: Tom?

MR. SLOAN: Yes. Just a quick note for the EAC members. You know, a lot of our reports

we time to finalize for December. That's well past their deadline. We need to make sure that we're coordinating with their schedules even more importantly than coordinating with ours. Thank you.

CHAIRMAN COWART: We had discussed this earlier at the Leadership Committee meeting and came to the conclusion that it would actually probably very helpful to submit the outline and the list of initial thoughts that the subcommittees were working on. It might even be easier for you just to be able to identify the topics that we're paying attention to at an early opportunity so that you could then say, oh, that one is something we're struggling with, and we'd really like to hear more about that.

It would help to focus our work, and it would help us to deliver content to you in an abbreviated form without waiting for final papers at the end of the line.

MR. MANSUETI: I would think that would be extremely useful just seeing an outline.

[Off audio comment.]

CHAIRMAN COWART: There you go.

MR. PECHMAN: Thank you, Carl. I'll get to work right now.

CHAIRMAN COWART: Merwin, Mike, and then Granger.

MR. BROWN: Merwin Brown, CIEE. You mentioned something about a National Lab was working on a future architecture for electric grid. Maybe I don't quite understand what this is about, but I know a couple of years ago my team got asked to do something similar. And we very quickly ran into a problem with all of the great uncertainty. We ran into too many Ys in the road, if you will, branches that if this happens, this is the way you go, if this happens, such that we couldn't come up with a sane approach, to come up with an architecture. And instead, took a scenario approach.

And I was just curious if you could elaborate on how that's going.

MR. PECHMAN: It's going in the

statement of work phase and through contracting, so we haven't gotten started. But we'd certainly be very interested in having you looking at what we're doing. And perhaps when Carl Imhof is here tomorrow, you and he can talk about the project.

MR. BROWN: I know Carl quite well. We used to work together at PNNL.

MR. PECHMAN: Okay.

CHAIRMAN COWART: Mike?

MR. HEYECK: Mike Heyeck. Just a couple of comments. Number one, actually we do have a library of documents over the last two years. For example, next generation energy management system, the fact that the control points in the grid are increasing by many orders of magnitude, especially now when you get down to distribution where you'll need grid operators at distribution levels. So next generation energy management system.

We have grid security. We have a grid resiliency paper. We have intersection of gas and electricity. This is just a transmission sector. There's a huge body of knowledge in the Smart Grid

Committee and the Storage Committee. So if that could be put forth for the record for the QER in some form.

In the QTR process, I'm just going to give you my frank comments. I as one member was very frustrated because I was the head of the Transmission Committee. I didn't know how to submit anything besides the documents, and they weren't submitted. And then we were invited to a session to provide commentary or remarks, testimony, but none of us could speak for the EAC. We could only speak for ourselves. So it became a very fragmented process by which this committee could talk.

And then I would go back to my first comment. If we could get the body of knowledge that was submitted in the last two years of this committee to this QER process, that would be great, and then augment it with the current activities.

The last comment I'll make is an old physics professor told me never believe

extrapolations. And I'd just encourage you to think about the discontinuities, just think about when I started on this committee, shale gas was not even a party to the puzzle, and we wrote a report called "Keeping the Lights on in a New World." Well, the new world changed in about 12 months after that report.

So there's other sectors and other industries that actually are going through what we're going through in this industry, and I'd behoove you, recommend to you that you look at other industries, such as the financial sector, such as the cable industry, to see what they're going through and how they package things.

Just one example, in the cable industry where the wires are becoming fixed charge, very rudimentary whereas everything else is becoming packaged. And that might not be different than our future.

So wide-ranging comments, number one, on process. Number two is just open the mind and look at other sector, and I'm sure you are.

MR. PECHMAN: Thank you. We do have issues with respect to the FACA, that we haven't looked into. So, I mean, that's just a legal constraint that we as a Federal agency have to deal with.

We're keenly aware of the unknown knowns, and the issue of how to bring those into the processes is obviously very difficult. One of my first projects when I was a staffer at the New York Public Service Commission was reconverting Ravenswood III in New York City from oil back to coal. And it was also the first power plant that I was ever in when I was a high school student in New York City, and remember asking the operators of the plant who were giving us the tour why are you still burning coal. And they said, oh, we just converted to oil.

It's a constantly-changing industry. You can't predict where you're going to be, what the role of nuclear is going to be. Everything that we think that we know today is likely going to not come to fruition. Something else will

happen. But we still have to make an attempt, look out in the future, see if there are no regrets, strategies that we can adopt, and handle the surprises as gracefully and as successfully as we can.

CHAIRMAN COWART: That's such a great phrase, "handling surprises gracefully." It sort of summarizes many of our careers we hope. Granger?

MR. MORGAN: So I have two questions that take the form "to what end." I mean, I'm obviously aware of the Quadrennial Energy Review. I actually was one of a handful of folks who got invited in a few years ago to talk to PCAST when they were still trying to figure out what they might do in this space.

So starting at the more micro level, you described this model that you're trying to get built of the transmission system. To what end? That is, what sort of things do you plan to be able to do with this tool once you've got it? And then at the higher level, so you go through this

entire review, the first round, on energy transport issues. What's likely to come out the other end? I mean, so I understand there'll be a lovely document, and it'll sort of describe the state of the world as it is and where it might go. But to what end? What will then happen?

So let's start at the low level stuff with the model of the grid.

MR. PECHMAN: And I think you recognize that we're trying to create a conceptual model of the grid and not a model of how it will --

MR. MORGAN: Yes, that's fine. I at least have limited ability to imagine what you're going to do with it once you've got it, what other questions you can --

MR. PECHMAN: Well, I think the various questions we're going to ask are getting to that end point, what does that tell us about what our next steps in terms of R&D investment policy need to be to move towards that step. Does it support the process, for example, that New York is taking in terms of looking at, and that we're seeing out

of the California -- sorry -- the California ISO in terms of different ways of incorporating distribution and talking about the role of distribution and the level of control of distribution.

Does it identify needs? If it identifies needs, what do we to fulfill those needs? Starting here, I can't tell you what the end point is and how we're succeed because we don't know what we have. I do know that we can look at past energy plans and that we can see, for example, that the earlier energy plans did talk a lot about the need for the retail access, the creation of ISOs and things of that sort. And then that led to Federal legislation that enabled those entities to be created.

MR. MORGAN: I guess I'm thick -- sorry.

MR. PECHMAN: No, no, I would never say that.

MR. MORGAN: Oh, you're welcome to. But, I mean, for example. Can I ask this thing? Should I break up the Eastern interconnect with

D.C. back-to-back connections in order to provide more secure or resilient supply, or is it not -- I mean --

MR. PECHMAN: We're not going to be able to go that level of detail or even analytically ask that question.

MR. MORGAN: Am I the only person around the table who doesn't understand what this thing is going to do because I certainly don't, but I'll stop now.

MR. PECHMAN: Well, I think, I mean, the high level is road map to the future, whatever that road map means, but we're not there yet, and we have a lot of work to do in between now and when it's done. And hopefully at the end of it, you'll say, ah, I see at least one thing that I hadn't thought of that might be a good policy or a good investment to pursue. And if that's the case, that will be successful.

But I can't predict now to what end because this is a planning document. This is a planning process. And we're soliciting input from

experts such as yourselves to help us formulate to what end and to create the end point. So to the extent that you, for example, see a void in transmission and distribution policy and you bring it to us and say, you know, I've been thinking about this issue for 20 years, and I don't understand why X, Y, and Z is not being done. I don't understand this whole issue with micro grids, on who controls the micro grids, whatever the issue is. We can take that, look at that, and then help develop whatever that end is.

MR. MORGAN: You want to have a crack at the higher level to what end?

MR. MANSUETI: Yes. Granger, you're asking tough questions, but questions that need to be asked, and it's fair.

MR. MORGAN: That's why they pay me the big bucks to sit here.

(Laughter)

MR. MANSUETI: Well, first, the stock answer is the QER is going to come up with three things or has the option to. One is any

particular actions that the executive branch should take, okay? Anything that the executive branch should take in terms of R&D on energy issues. And the third one is any possible legislation.

And you look back or when I look back, the only one that I was involved in in my short career in the Federal government, the 2002 National Grid Study. You could say that perhaps maybe the last QER done in the executive branch. Even the 2003 Blackout Report. Both seemed to bring, and they resulted in legislation or actions by industry to fix a problem. And in both cases, they seemed to bring together where people already had been thinking is that the lowest common denominator, is that no regrets? I don't know.

But in seeing that things came out of that. What will come out of this? We don't know, but the thought is let's give it a try. That's the Energy Secretary's job.

MR. MORGAN: Okay. Thank you.

CHAIRMAN COWART: Merwin?

MR. BROWN: Merwin Brown, CIEE. Is it possible that the most valuable outcome that could come from your report would be identifying this fact that the future is so uncertain, and that needs to guide future activities and things like that, that that is kept in mind because it may help avoid someone coming up with a solution and putting it in concrete, and then two years down the road we regret it. Just thought I'd pose that question.

MR. MANSUETI: I see that, yes.

CHAIRMAN COWART: All right. Thank you very much, gentlemen. Did you have an answer, Carl? Did you want to add to that?

MR. PECHMAN: No.

CHAIRMAN COWART: Larry was so succinct. He just said "yes." All right. Thank you very much. We're past the time on this panel, so I'd like to move us along. And we're now -- Clark, you've already risen. All right. I'll turn it over to Clark Gellings for the next couple of items.

MR. GELLINGS: I have risen. That's good. I'm doing it at the bequest of David Till, who's the chair of the Delivery Subcommittee. And what we had decided to do was to do is put a couple of presentations together, and one of those will include a panel. All of this to help us think through our outline, Carl, to see if we're missing anything. It's quite a task to say what's the power delivery system of the future going to look with all of the uncertainties, and we've heard some of those comments already.

So the way we're going to do this is, first, we're fortunate enough to have a presentation by Ron Melton. Ron is the Director of the Batelle-led Pacific Northwest Smart Grid Demonstration Project. And he's also the Administrator of the GridWise Architecture Council, and he's the team leader for Distribution Systems and Demand Response at the U.S. DoE Pacific Northwest National Labs. He's got quite broad experience, as you might guess from those few items that I've mentioned.

I'll introduce the panel of which I'll play a role after he's done. And so, I think you'll enjoy very much some of the work that he's been doing with others don this issue of transactive energy. Please.

MR. MELTON: Thank you. Well, good afternoon. Thank you for inviting me to come speak to the committee.

The GridWise Architecture Council, for those of you who are not familiar with it, is a group of 13 independent domain experts who volunteer 20 percent or more of their time to work on issues associated grid modernization, in particular enabling the interconnected communicating smart grid of the future. So the topics of discussion that we've had so far this afternoon are very much the nature of the same sort of things that we discussed at the GridWise Architecture Council.

Now, in the spirit of full disclosure, one of the council members is in the room with you. I'm sure he hasn't made a secret of that,

but Tom Sloan is one of our current members, along with a number of other colleagues representing a full cross-section of the different stakeholders of the electric power system.

Over the past several years, the Architecture Council has been spending quite a bit of time on the topic of transactive energy. This past fall we issued something called the Transactive Energy Framework Document, which is being circulated and we've been receiving comments on that.

In the recent follow-on discussions that we've had, we've had a meeting at PGM trying to engage the ISO RTO community in particular because they always ask the question, well, what do you mean by this transactive energy stuff? WE already do transactive energy. And, of course, they're right. They already do. The use market mechanisms. They use supply side elasticity and supply curves as a first approach, at least first from my point of view, to how do we balance the system. How do we control the system looking at

it from a large, broad point of view.

But as we all know and as we've heard articulated very well in the previous discussions this afternoon, the system is changing and changing dramatically. Increased penetration of distributed energy resources, increased variability both on the bulk power side with renewable resources such as wind, but also in the distribution systems on the consumer edge, also with renewable resources, particular photovoltaics, and distributed energy resources kind of scattered here and there, plus, of course, increasing numbers of intelligent devices, the internet of things becoming a reality. And we see here in the diagram a representation of all of these different moving parts as we've sort of got them scattered around in the system now.

So how do we coordinate? How do we manage, and in some sense, how do we control or at least affect the behavior of all these new moving parts? There are new approaches needed to such things, and transactive energy is emerging as one

of the possible ways to do that. One way you might think about transactive energy is an application layer of smart grid that's got a convergence of control and economics to affect the overall coordination of the different resources.

So as I mentioned, we had one of our recent meetings at PJM, and one of the key problems that we identified at that meeting was the need to be able to articulate these concepts to regulators, to policymakers, to legislators. Tom is sort of one of our guinea pigs in this regard, to decision makers, utility executives, and so forth. And many of them when we start talking about just hear geek, geek, geek, blah, blah, blah. And so, we said, okay, we've got to take a step back and come up with some mechanism for communicating with them.

So we've put together a transactive energy infographic, and I'm going to use that infographic for the remainder of the presentation here partly to test it on all of you, but also because it does help us communicate some of the

key ideas and key concepts.

So this is a simplified version of our definition, but it gets across the key points. First of all, we're generally going to be talking about prices and real-time prices for the most part as the means of engaging customers. And we're not just certainly talking about homeowners and residential consumers. We're talking about customers at all scales of the grid. And in many cases, those customers are becoming not just customers, but also providers. And so, how can we engage them in the producing, buying, and selling of electricity, recognizing that much of this, if not all of it, will be automated, and still have that reliable and cost-efficient electricity system? So transactive energy, this is sort of the objective statement for the overall functionality.

Revisiting the motivations of why is it important, well, we heard this morning early on, customer choice is a key aspect of things. Customers want to be in control of how they

interact with the electric power system. And so, this is one of the key objectives, one of the key drivers. And it responds, for example, to the challenges that Kevin Lynn laid out this morning and the overall approach that EERE and the Grid Tech Team was taking and OE.

Secondly, and, of course, we've heard about this as well, clean energy resources are here to stay. There are some people who don't like them. There are some people who complain about them. My dad's neighbor has a home in a rural community where he gets to look out his picture window at the wind farm, and he hates it, but they're here to stay. They're not going away just because he doesn't like looking at the wind farm. And so, how do we effectively engage these things so that we can maintain an overall system that's reliable, that's efficient, and that takes full advantage of these resources?

Back to customers again. Now, the customers want to be engaged, and the customers especially want to prioritize what matters to

them. And this is going to be different for different customers. We see, for example, some of the big box stores beginning to take their energy future into their own hands and go out and perhaps come up with their own relationship to the large-scale providers. We see Apple, for example, with the Cupertino Campus project implementing their own corporate campus micro grid with their own energy resources. And they can be on grid or off grid as they decide matters to them.

So how do we coordinate that? How do we make that an asset for the grid overall, not a question that we point to and wonder what to do about. And, of course, speaking of micro grids, micro grids seem to be emerging as a new piece of the system. How do we take full advantage of micro grids? How do we know how to use a micro grid to help us with the black start of a larger chunk of the grid? What kind of simple signaling can we do to let the micro grid behave in a way that's useful in that black start, and yet also support the black start?

So these are some of the challenges. These are some of the types of things that we're trying to incorporate into this thinking about transactive energy.

So let's take a look at some of the ideas about how it works. And one of the challenges the Architecture Council has in doing this work, there are several of us, myself included, who have specific techniques -- in our case, transactive control and transactive coordination on the Northwest Smart Grid Demonstration Project, on the Olympic Peninsula Grid Wise Demonstration, and on the AEP Grid Smart Demonstration, where we've got specific techniques. And it would be really easy to stand up here and explain to you our specific techniques, but that's not what this is about.

We're trying to take a step back, articulate these concepts in a more abstract, more conceptual way so we build a community where other people come forward with their techniques as well, and we can compare, and contrast, understand what

works in what situation, and hopefully get best of breed solutions that emerge with the different challenges that we're trying to address.

So our graphic again represents the different moving parts of the system, and I'm hoping there's a laser pointer feature here. I'm thinking that might -- no. Well, the graphic illustrates the different moving parts, and I'd like you to notice a couple of features on the graphic. One is the placement of industrial consumers and producers on the boundary between regional and local or distribution systems. So these are becoming more and more a bridging element, as I mentioned, with things like the Apple Cupertino Campus project, which can live in various relationships with the rest of the grid.

Retail energy providers also on that boundary. They have a relationship to both sides of the equation. And new energy service providers well within the local boundary there, but we expect to see the emergence of new energy services, some of them first degree just providing

energy, but some of them second and third degree values based on the analysis of the information about how energy is transacted and used and so forth.

So new customer choices begin to emerge from the residential side. Thank you, sir. New customer choices begin to emerge on the residential side through the engagement and the flow of information in the system. We see here in the example, of course, we've got some rooftop BV. We've got some electric vehicles and so forth. How does the customer get to take full advantage of those as things they've invested in, but also how does the grid get to take full investment of those?

Well, it's through the communication of information, both directions. What does the grid need as reflected in price signals? In our case, we tend to talk about those as incentive signals, and what the customer communicates back is what they plan and intend to do so the grid is informed, achieving one of the objectives of the

ISO RTO community, which is better visibility of what's happening on the distribution side.

Of course, the micro grids begin to pull that all together in local communities. The same type of things are required in that case, the flows of information, so that there is ability to maintain and coordinate the integrity, reliability, and resilience of those and to enable those micro grids to communicate the next layer up for the same purpose.

I mention the expanded services. This is key because we think that one of the things that got to happen in the evolution of the system is the revealing of value, and through that revelation of value, opportunity emerges for commercial entities, for new players in the system. It's similar to, if you think back to smart phones before they were smart, what made them smart, of course, was adding the ability to share information broadly. And that enabled the creation of things we hadn't even imagined yet that we now call apps on our smartphone that do

all sorts of things for us we didn't even know we needed done. So imagine that at least in part in your energy future.

Speaking of that value, though, one of the key principles we think is important here is alignment of value so that the value streams of the customer are aligned with the energy service provider, are aligned with the distribution system operator, are aligned with the market operator, and the transmission system operator. When those value streams get out of alignment, then they are competing in logarithmic ways, which could be the bad things happening in the system.

And finally, looking at the larger picture, as I mentioned, one of the key statements that we've heard recently from the ISO RTO community is we need better visibility into what's happening in the distribution system. But they recognize it's not realistic for them to try to control everything that's happening in the distribution system. Not only would there be great resistance to that, but it's not even

practically possible. In an article that was in the June issue of IEEE Spectrum, "The Rise of the Personal Power Plant." And Clark is quoted a bit in that article. It points out that the emergence of hundreds of thousands or millions of points in the system that are transacting in some way is in the future of the power system.

If you imagine that number of elements transacting and operating and hopefully interoperating, you realize that we can no longer expect to do centralized optimization calculations to try to control all of those things. So we have to have distributed approaches that reveal information to the bulk power site so that it understands what's going on and what to do expect as the system operates, but at the same time take advantage of local control, local optimization to help achieve global optimization results.

So what are some of the benefits that we see would accrue form these type of approaches? Well, first of all, there's a need for liability through the integration of the different elements.

We heard Paul Centolella before he left mention the need, especially on the distribution side, for integrated information architecture, integrated control architecture, and integrated market designs. Absolutely. That's what we have to have to achieve this reliability result through that integration to manage all these moving parts.

Affordability. Because of the empowerment of customers to make informed decisions about the way they use and participate in the energy system, more affordable solutions emerge for them. Sustainability. This is both a benefit and a requirement, if you will. These approaches aren't something that you can just come in and sweep away everything we've got right now and bolt all this new stuff in. But these approaches are approaches that we think can be implemented incrementally to modernize the system on a step-by-step basis.

And finally, efficiency. One of the keys here is the convergence of economics and control and the use of the power of economic

activities and markets to help drive the efficiency of the system, and continue to have a reliable and energy efficient system in the end.

So this may seem to you, if you're familiar with the GridWise Architecture Council to be new business for us. The Architecture Council is well known for the interoperability context-setting framework in the so-called GWACK stack on interoperability. But, in fact, transactive approaches are one of the earliest motivations for that focus on interoperability.

This is a slide from 2005 just after the Architecture Council was formed, and this is the final build-up of an animation sequence which contrasts trying to have large number of devices, in this case, the grid in a building, interacting through conventional call-up, make a contract, lots of paper flowing back and forth. It doesn't get you where you need to be. And this shows the interoperability-enabled transactive interface that was a desired future state.

As I mentioned, the Architecture Council

has been trying to broadly engage a set of stakeholders in this through a set of different workshops that we've had starting in 2011. And we've hopefully had some success in that, but we feel that there's a continuing need to engage stakeholders broadly. The regulatory and policy community, the utilities themselves to understand business model and value creation opportunities. The utilities and the vendor community to understand conceptual architectures and ultimately physical architectures for these systems. And the vendors as well on the cyber physical infrastructure that's required to implement these.

So what are the next steps for us? Well, we're in the process of updating the Transactive Energy Framework Document. It's available if you're interested on the Architecture Council website, gridwiseac.org. We're also putting together a number of different documents. The infographic, we've put together some TE principles that are high-level statements of requirements. We're working on an article we call

"Transactive Energy in 1,000 Words." That should be out soon.

And last, but not least, we're planning right now for the second internationally conference on workshop and transactive energy to be held in Portland, Oregon on December 10th and 11th, co-coordinated with the SGIP meeting to be held that same week in Portland, Oregon.

So with that, thank you for your attention. I'll stop and hopefully we have time for questions.

MR. GELLINGS: Thanks. Good job. I think we do have time for a few questions, and we will have another discussion period when the panel is finished. Carlos?

MR. COE: So, Ron, great presentation.

MR. MELTON: Thank you.

MR. COE: The one question I have is value alignment. It's easy to say and hard to do.

MR. MELTON: Yes.

MR. COE: So I've been to a lot of discussions on rate structure and things. And one

of the things that seems to be missing in rate structure is sometimes you don't understand the idea of giving the right incentives to give the right effect. And the question is in value alignment. Are you taking that into consideration to come up with maybe new ways to promote, I mean, because in a sense what you would like to do, if Apple had the right incentives, they would structure their micro grid in a different way than they're doing today.

MR. MELTON: Perhaps. I guess we've thought about value alignment in a sense a little bit more architecturally. And if there's any aggregators in the audience, they might not like what I'm about to say. But if you think about the way that aggregators operate today, they're often operating on the side, if you will, separate from the distribution system operator and perhaps even the energy service provider.

So imagine a future situation where I have a wind market of some kind that's incentivizing behaviors to help integrate wind.

And I have an aggregator that's not aligned with the distribution system operator and the energy service provider, who's participating in that market. They may send a signal to a lot of end points on the grid, say, people with electric vehicles. There's a huge wind up ramp. Everybody charged.

Well, if everybody starts charging without there being alignment with the operational considerations of the distribution system operator, I may do some serious bad things in the distribution system. If there is alignment of the aggregator with the distribution system operator, then the distribution system operator has a chance to modulate the aggregator's require or incentive so they can maintain the integrity of the distribution system in concert with the aggregator, you know, sending their signal that causes people to want to start charging.

MR. GELLINGS: Granger?

MR. MORGAN: That's very nice. Could we go back to the overall diagram?

MR. MELTON: Yes. I'll try to, let's put it that way.

MR. MORGAN: Yes, that's good. Well, okay. Yes. So when I look at this, what concerns me is who owns what and who sets the rates. So in the left and bottom portion, we've taken that apart in different entities on things, and there is a transactive market, as you say.

In the upper right corner, however, all the wires are still owned by legacy utilities. I can't sell power to somebody else. I mean, I can only deal with my legacy utility. And furthermore, at the moment the rate structures basically assume that I have to pay a rate so that if I go offline as a distributed generator, there's a potential cost to the supplier. But there's no recognition of the fact that if I have a distributed generator, I may be helping the distribution company or maybe even the transmission company.

So it strikes me that ownership, and who set rates, and what gets included or not included

in rates is absolutely critical to the upper two right boxes.

MR. MELTON: Absolutely, and this is sort of the heart of the whole discussion. So these are partly about ownership and partly about function. And we don't want to assume a specific model, whether it's a distribution operator and energy service provider or the two combined. But the questions you were just asking are absolutely the kind of questions that have to be addressed by any specific formulation of a transactive energy approach.

MR. MORGAN: So one other comment. I mean, at the risk of insulting some of my utility colleagues around the room, U.S. utilities have not been the most innovative entities in the country. Yes.

And so, the issue of who owns what can also have a big impact on the rate at which innovation occurs.

MR. MELTON: Absolutely right, yes.

MR. GELLINGS: I'll take Sonny, then

Barry, Patricia, and then we'll move on. We'll get you later, okay? Sonny?

MR. POPOWSKY: Thanks. It's really a question for you and for Tom Sloan as well. My concern is from the residential customer perspective, I think you said customers want to be in control of how they interact with the electric system. That hasn't been my experience, I guess, talking to residential consumers over the years, and I still do that a lot. I still do a lot of consumer education. It's almost sort of the last thing on their mind is how they interact. They want to turn the lights on. They want the lights to be on. They want to get a reasonable bill at the end of the month.

How have you dealt with the residential consumer issues in the GridWise Architecture with your constituents, Tom? How do you bring them into this?

MR. MELTON: So, first of all, you're absolutely right. People we found on the grid wise on the peninsula demonstration, if you were

lucky, you could get somebody to think about how they used energy for one hour a year. So that's why all this has to be highly automated.

But we do see with the emergence of rooftop PV in many parts of the country people are concerned about how they interact with the electric power system in some ways. And we have to enable them and empower them to keep that as simple as possible so their main concern is turning the switch on and the lights come on, but not tell them that means that somebody is going to reach through the meter and start taking control of everything in their house.

MR. SLOAN: Yes, and if I may follow up on that, Sonny, because I, too, have found that most people don't even set their programmable thermostats. So the idea that they're going to interact on a regular basis is kind of out there.

What we have talked about is a distinction between, you know, the commercial sector where you do have energy managers, and they're becoming more interested in interacting,

and those residential customers, as Ron said, that are putting PV sets on their roof, or having wind turbines in their backyard, or having electric cars they want to be able to buy and sell. So it's a very small, but it's often a very vocal group.

And I think what we're trying to do is say as that segment grows, the grid system has to be able to accommodate it.

MR. MELTON: And one of the key challenges, of course, is how to incentivize them to care enough about this to try some new things out. In the Northwest with electric water heaters, if I remember right, it's about 4,500 gigawatts of demand response potentially available. That's a huge resource relative to things like wind integration if we can get people to care enough about participating.

MR. GELLINGS: Barry?

MR. LAWSON: Thank you. Two quick points and then one question. First, I would say keep this a customer choice, not a mandate. I

think you've heard already from Sonny talking about whether this is a primary focus of the residential customer. Second thing, second point is many who look at this kind of a setup and talk about these issues don't realize that most of these folks still want the electric utility to still be there for them when their systems don't work, and they don't realize that there is a cost to that. And a lot of times I think that's lost in this discussion.

If you still want to be interconnected, you still have to pay. You're not paying for energy. You're paying for the facilities to be there. And then if you use the energy, you're paying for it. But I think that gets lost here often.

One thing you said that sort of struck me was that ISOs and RTOs want visibility into the distribution system. And I think they've got their hands full with the transmission system these days. Maybe you could expand on what they want to see down into the distribution system that

even, you know, is related to their formal role.

MR. MELTON: Well, one of the things I can tell you about specifically because the Chief Economist at PGM gave us a presentation on it at the GridWise Architecture Council meeting there, was they want to see revelation of demand elasticity. They want to understand what those elasticity curves look like.

You know, PG&M, for example, has a five-minute market that assumes that you could have demand of participating in such a market. But they don't understand, well, elasticity curves. So that's just one example.

MR. GELLINGS: Patricia?

MS. HOFFMAN: One thing in all this that I think we need to think about is, what is the problem we're trying to solve? And I go back and I look at it from my perspective. When we start talking about the distribution system, what we're talking about is very tailored solutions to a specific problem that a distribution entity may have. I mean, on the bulk power system, you're

looking for competition. You're looking for, you know, things that could be provided in, I would say, a variety of locations in support of the bulk power.

But when you get to the distribution, you're really talking about tailored solution, or if you've got a specific constraint on the system that you're looking for a specific solution. In the olden days, I mean, you did either direct load control or the utility could tailor the solution that's sent via, you know, a traditional load control mechanism. When you're looking at market systems, it's how do you provide that, you know, price structure to provide a very tailored solution set.

So you don't have to say, all right, I want everybody, you know, in the whole State of Texas to do X. You only really need a certain set of customers to provide a certain response of what you're looking for. And I think we've got to keep that in mind.

So if we take a step back, what we've

got to think about is what is the transparency we need to have with the distribution utilities, with the regulators, with the customers to understand that there is a problem that is trying to be solved by doing X, not that we're just trying to create, you know, some sort of extravagant market structure.

You know, I think we need to get back to being very clear that it's what the system requires as a starting point.

MR. MELTON: Yes, very good. Thank you. I agree 100 percent with that.

MR. GELLINGS: Thank you very much.

MR. MELTON: Yes, that's the one you gave me. But I have copies of the infographic I'm going circulate around, so wander through it.

MR. GELLINGS: Could I ask my panel to join us up here, please? So we'll have, I hope, a few moments to capture a couple of those. I saw the tent cards go up after we were still debating, and sorry about that. Boy, you could talk about these issues for days.

First up, let me quickly introduce each of the panelists. I'm going to participate as well regarding a specific issue. Doug Larson is with us here. He is the Executive Director of Western Interstate Energy Board. Just in brief, 30 years' experience in the Western Regional energy issues.

Stan Beuning is the Director of Market Operations for Xcel, and another 30 years of experience in energy market design. I won't tell you how many years I've had because I'm going to embarrass myself.

Mike Kormos, Executive VP of Operations for PJM. And Carrie Cullen Hitt, Senior VP for State Affairs for the Solar Energy Industry Association, also all with a wide range of experience.

So some of you have been engaged with us in this conversation, and certainly our colleagues at DoE and us have been coordinating here. In fact, specifically some of the frameworks for benefit cost assessment frameworks that we've

developed with DoE, which come to the fore here. This is the same thing I'm going to give a piece in Michigan, and so pardon me for not changing the title here.

The subject is the integrated grid. The basic premise here -- I loaned him my pointer, so now I'm going to use that. I think you know who we are, EPRI. Our basic mission is reliable, safe, affordable, environmental responsible electricity. And, of course, we've been discussing this issue about how the power system is evolving, distributed resources of all kind.

We keep going back to solar, but that's only a small part of the overall issue. We're really talking about everything from affordable tanks certainly to micro generation of various kinds, storage, plug-in electric vehicles, and fuel cells. And maybe importantly, the unknown appliance, okay, whatever that is.

And I say this purposefully. Some of you heard me to do this anecdotally, but when I used to testify as a key witness for a major

utility, I always tried to put it into the forecast of unknown appliance because about every 10 years something comes up that we hadn't seen before. Well, I gave up on it because I got beat up real well. It always sort of like, Mr. Gellings, would you define the unknown appliance.

So the point here simply being as we start thinking about the flexibility we want to build into the power system, we need to think about how that flexibility would allow us to embrace technology that we can't even really perceive just at the minute. We know the grid provides transactional value because it allows the ability for some of these consumers to sell back to the utility provider all the arrangements.

We also know the grid provides and functions and as balancing resource, provides reliability, provides start- up power without the grid. It would be difficult to start up some of the appliances we have in our homes, even a central conditioner. We can engineer around that, I know all that. But we know the grid provides

enormous value. We know the grid also costs, and those costs are not necessarily reflected today. Capacity costs for an average residential customer about $51 a month. I didn't say that's what he pays. That's what it costs us to provide that capacity.

And the point here is that if we don't figure out how to balance between volumetric energy charges and capacity charges, we're going to run into a problem with compensating adequately the utility. And the idea which has been displayed in a couple of different diagrams now -- Ron had a nice one -- but the idea is we're going to have various sets of local energy resources, which we want to make part of grid operations and planning, and how do we do that?

And so, I'll go through this slide, and then I'm going to stop and not do the rest of them. But the question is how do we understand, and then organize ourselves to carefully analyze the system impacts of distributed energy resources. No big deal. We have two percent out

there or something like that of penetration. Don't care, okay? But what we're all trying to address is what happens when we really get serious about it? And it's going to happen, right?

So at first, as customers adopt these devices I've got good voltage support and I've got some loss reduction that occurs. And actually that goes on. At some point when I get high enough penetration, I can avoid some capacity, particularly on the T&V system. I can reduce losses at sub- transmission level. And eventually if I get enough of them and I have some control over them or at least good visibility, I can offer frequency support to the system, and realize some energy capacity and ancillary services from these distributed energy resources.

The bad side of this is that as I start penetrating, and really this is on a feeder-by-feeder. Somebody intimated that already. This is a really on a feeder-by-feeder basis. I've got potential issues with voltage support. I can end up with down and out capacity

issues. I can get reverse power flow, reactive power balance that's out of whack. I can get increasing re- dispatch from transmission constraints. And eventually I don't do something from a technology point of view, I end up with voltage and frequency stability issues and generation capacity ancillary service issues, the California duck curve. And I could put it up and we could have at that for a while.

Okay. So what are we doing about it? We are establishing a benefit cost framework, not re-einventing a bunch of models, but using existing EPRI and DoE models, and stitching them together in a way that we can provide tools to the industry to do this. There's more to that than just those. There's also the issues of interconnection and regulations that have to be modified. There's the issue of informing regulators and legislators. I'll try my best on whatever that date is, Tom. It's coming up soon.

And so, IEEE 1547 was mentioned. Still a problem. I said this at our last meeting. Even

if 1547(a) is successfully balloted, which it probably will be, then we still have to get every state to adopt it, and that may not be the easiest thing in the world.

So the point of doing this and inviting these good folks is to get some different views on what this may all look like in the future. So I'm going to take them in the order that they're listed on the agenda. Doug, I'm going to ask you to go first, if you would. Would you put his material up, please?

MR. LARSON: Thanks very much, Clark. So at some point I'll be able to control the slides, or do you want to just advance them?

MR. GELLINGS: No, go ahead with the slides, Doug Larson's.

MR. LARSON: So while they're looking for that, let me start. I work for an organization of 11 Western states and three Western Canadian provinces. Our board of directors are appointees of the governor or their premiers. And our geography is -- actually the

comments are my own, not the organization's.

I should add, if you go to the second slide. So my perspective is from the Western interconnection. Unusually we have low or no load growth. This is uncharacteristic for the West, a generally growing region. The chart in the upper right actually is some work that Lawrence Berkeley National Lab did for us. If sort of deployed currently available efficiency technology, we end up with negative load growth in a lot of the states.

We are also seeing, contrary to popular perception, a decline in the use of the existing grid. And we're likely to see more of a decline in use of the existing grid as we retire more coal plants. Typically these are the ones 500 or a thousand miles from load centers.

We operate a highly-fragmented grid, unlike most of the country. We have 37 balancing authorities. That's what's on the map. We have 54 transmission operators. Each is essentially their own fiefdom. We have a number of major

transmission projects proposed in the West. They are not going forward, and they're not going forward because there's a lack of demand for the use of the wire, not because of permitting problems or financing problems. Nobody wants the pile-up that the long distance would deliver.

And part of this is driven by the dramatic drop in solar costs, and I think it's dropping faster than any of the competitors. So if you go to the next slide, this is data from EIA. It shows a cost of generating options over the last three years. The bottom line here is that solar costs have dropped substantially while the costs of many other generating technologies, particularly combustion technologies -- to me there's nothing to suggest this trend is going to change. These are driven by international markets, not things like U.S. DoE investment in technology.

So my central observation is 40 years ago we had an electric system which was heavily reliant on local generation. For the past 40

years, at least in the West, we've moved to creating a system with large centralized generation, typically coal plants, again 500 or a thousand miles from load centers. We invented more sophisticated SCADA systems and control systems to manage this far flung network. It's very different in the East, which is much more of a mesh network.

In the 21st century, we're likely to head back to where we've been in some regards, except with regard in the sense of having local generation or distributed generation being the dominant source of power. And the difference being is we're going to have a lot more sophisticated controls than we had last time around.

So what might accelerate or retard this trend? Obviously battery breakthroughs. In the extreme, it's a tipping point. It enables people to leave the grid economically. PV improvements, again I think they're accelerating, probably driven by worldwide demand as much as U.S.

investment. Pricing systems may spur innovation at the distribution level. That would accelerate this trend that I think we're seeing anyway. Entry of new market participants, which we are already seeing, solar city. Getting into both the solar business as well as storage business. Or existing companies deciding to reinvent themselves.

So what could retard this kind of trend that's already under way? We have some new breakthrough in central station technology to undercut the cost of solar in the future. That could retard this. Institutional resistance by utilities who want to keep the status quo. Clearly that will retard the speed at which this transition will occur, but not probably not stop it. And the division of responsibilities between FERC and the states, the jurisdictional division here I think is going to become increasingly counterproductive as the lines between what's a distribution issue and what's a transmission issue get increasingly blurred.

So what does all this mean at least from a Western perspective? The transmission system might become a backup system used to balance energy, maybe used to delivering economy energy, things like hydro runoff, generate electricity in the Northwest to California in the springtime. We might see improvements in grid vulnerabilities and resilience from this kind of future. Clearly we're going to have a distressed distribution system.

In this kind of future we're going to need -- it's already been said here -- greater visibility from the volt power system into the distribution system with two-way communication. Better ways of accommodating the ramps, particularly in the West, the ramps that are driven by solar both at the utility scale and distribution level.

We're going to need to accommodate storage. We're going to need faster generation. We're sort of way behind most of the country in the sense we don't have energy and balance

markets, but we're about to get our first that covers multiple states. Faster generators. A responsive gas delivery system to meet the ramps as illustrated by California duck chart.

And we need to -- probably the hardest one -- redesign the relationship between FERC and DoE -- I mean, FERC and the state POCs. Yes, not in my lifetime, but maybe the next person's lifetime.

My last slide, these are some points of needs we have sort of in the near term. Deployment of new grid monitoring and control technologies. We've invested $100- and-some million in synchrophasors in the West. The data is flowing. We now need to develop applications. DoE has been very supportive in that area.

And along those lines, Pat Hoffman, you mentioned earlier about the meeting you had among the labs to sort of sort through whose expertise lies where. That would be very helpful for Western states to better understand that.

It would be nice to have some additional

work in fostering the response of distribution and consumer side technologies to support analyses of how this transition to a local/distributed generation is going to affect consumers. We've spent some time talking in the West about death spirals for utilities. Frankly I think that's less important than the future for consumers.

Smart companies figure out ways to make money no matter what the regulatory scheme is. PG&E, which theoretically is losing customers to distributed solar, they invested heavily in solar city. I'm sure they made a nice, fine recoup on that, and I think Warren Buffett, Commissioner, is smart enough to figure out he can make money off of solar plants as well as off utilities. So I don't think we really need to worry as much about the death spiral for utilities as we do for consumers.

We also need to support some regional solutions to aid in these ramping challenges. It's much harder to ramp for solar than it is for wind. We need some support work on grid

reliability as we transition in the West away from central stations which have a lot of spinning mass to a future which doesn't have much spinning mass. So these are sort of the near-term fixes from the perspective of the bulk power system looking how do we preserve our future as a bulk power system in the face of this transition to distributed generation, local generation.

But I submit that DoE's job is perhaps to look further into the future and consider looking at the problem the other way around. And that's what's needed to accommodate it end-state where most of our generation comes from the distribution system. And from this perspective, it may be useful for DoE to develop information on what will be needed in that kind of end state. And if you really want to step out on a limb, Pat, you could also begin to think about how would you rank areas as to their preparedness for this kind of future.

So, Clark, that's my quick comments.

MR. GELLINGS: Doug, that was excellent.

What we're going to do is ask each of the panelists to give their brief presentations, and then we should have plenty of time for great discussion. So, Steve?

MR. BEUNING: Okay. Thank you. While the presentation is getting called up, I'll repeat Doug's disclaimer. I'll inflict upon you a lot of my personal views in this discussion. And while the slides are coming up, I'll just mention a couple of attributes.

Xcel Energy has been ranked the number one wind energy provider by the American Wind Energy Association for 10 years running. So we have a good decade of performance with respect to renewable integration and the wind.

At a personal level, I'm President of a group called UVIG, the Utility and Variable Generation Integration Group. Our membership operates 50 of the 60 gigawatts of installed wind capacity in the United States, and we've recently changed our membership structure to expand our focus on solar systems and solar operational

impacts as well for our members.

I'll be very brief with my comments today. I can summarize things pretty high level. Markets are good in the evolving structure for utility operations, especially in scenarios where we have a lot of variable type generation that's producing this distributed bonanza that a lot of people are foreseeing.

One of the things that markets can provide in contrast to a stand-alone utility type operation is a broader view of situational awareness. How does the variability of the different resources on the grid impacting flows in subsequent reliability? How do we best respond to contingent operations on the grid? What resources should be deployed? Those answers are kind of inherent in a market operator's awareness of the grid in contrast to a stand- alone utility.

A market operator can provide for production cost optimization. I think some of the signaling that was talked about Ron's presentation is a good example of inputs into production cost

optimization.

There's one other thing that you get in a pooled regional market operation in contrast to the old utility paradigm of bilateral transaction activity. And that is by simultaneously netting all of your supply and demand into a single supply obligation target, you accomplish a diversity benefit. And as variable resources increase their penetration on the system, that offsetting cloud cover in one area compared to the sun coming out in another smooths the supply and balancing targets and makes a regional market more efficient than stand-alone utility operations. Lastly, regional markets by their broad view of activity can provide better inputs into regional transmission planning decisions so that we're not investing in unnecessary elements in the grid.

We've talked about the micro grids and the distributed generation developments on the distribution system. I have to share with you my view that small need is big. I think it's cool. If I could live on my island and have my local

system and backup storage on site, I would do it, and maybe everybody else in the room would, too. But there are those times and periods where if my local resources falter, I still want to have that resource to back up supply. I want it to be convenient.

As we're doing those type activities, I think it was mentioned in the dialogue, there's a value in that backup supply that requires a proper allocation of costs. And this regulatory snarl that Doug mentioned is something that I've certainly observed. I have an experience with getting a utility bill from a rural electric cooperative, which simply amended its rate structure to go from energy- based cost recovery to a facilities access charge.

And overnight my bill went up quite a bit. The utility sent me a letter that said, well, whether you use on kilowatt hour or a hundred, you're buying the option to get the backup from that grid. So you should be paying for that. One of the things we see with regulated

utilities like mine is that we don't necessarily have that regulatory flexibility to just change that paradigm overnight. And so, the homework that will have to be done to get to a case where there's a proper allocation of the fixed costs of the grid and the distribution system to customers who retain that option to fall back on regional supply is important.

Lastly, I think this is probably the most intriguing area for this room, and that is the philosophy battles that we're all facing. There are lots of different paradigms for how the grid should be accessed, paradigms in terms of how you evaluate your rights to accept deliveries from the grid or make deliveries to the grid, how those costs of the grid developments are allocated. My own personal opinion is we are evolving to a postage stamp rate design for grid access whether we want to admit it or not, and that a regional transmission organization becomes the money collector who allocates that cost to the grid investors. But we certainly don't have any

consistency on that theory at this point in time.

We also are seeing a lot of interesting battles right now in these regional market constructs with respect to how they allocate costs between themselves. PG&M and MISO, for example, were neutered by FERC early on with respect to being able to allocate costs to one another for deliveries between the regions for enjoying that. On the other hand, SPP and MISO never had that prohibition to charge for transmission service, and they're locked in an interesting battle right now with respect to allocating costs between the regions to the extent dispatch optimization flow impacts exceed some type of contract path entitlement.

And probably what would qualify as middle ground as we see the California ISO and Pacific core energy and balance market development in the West are where that issue being mooted to a certain extent because the EIM participants are saying they will only make deliveries of dispatch to ISO up to the level of reserved path rights

between themselves. So they're for the moment evading this issue of t4o what extent should full grid utilization occur as compared to the use of contract path rights.

But this is a big area, I think, for evolving regional markets, and it's kind of hidden with respect to the glamor of distributed networks and smart grids and things like that. But this is really where the dollars flow.

Lastly on this subset here, the market-to-market dispatch practices and the techniques that are used for border price convergence between areas that establish a market clearing price are not consistent in the industry. We see a lot of experimentation going on right now. I think this is another market design area where there can be a lot of work in the future.

And lastly, I think with respect to a philosophical approach to grid evolution is we have FERC out there with a pro forma tariff from a long time ago. And we still have in the interim not developed what I would call a transmission

customer's bill of rights. And as we see these policy decisions evolve at a broad regional level, how it impacts my utility as a consumer of electric grid delivery rights is very much at risk. You know, a policy change can have a big impact with respect to my ongoing costs for regional delivery rights, and I have very little assurance that any of those entitlements are cast in stone or that what I'm paying for today I will continue to get in the future.

Examples include regional organizations that are adopting practices more hostile to capacity resources from outside their footprint. Well, I've invested in transmission facilities to accommodate those deliveries over time, but as the regional access paradigm evolves biased against external resources, my rights are eroded.

So there's issues like this in terms of the philosophical underpinnings to these market designs that we sure have to keep our eyes on as we're doing the analysis going forward. That was all I had.

MR. GELLINGS: Thank you very much. Appreciate that contribution. Mike?

MR. KORMOS: Good afternoon, and thank you. And I'll offer my disclaimer that, again, I'm not speaking PJM. I'm actually speaking for Terry Boston. I still have the slides from him. So these are my CEO slides that I happened to borrow. So that's going to be his opinion mostly.

I think everybody knows PJM. I'd just throw the slides up there in case you are not as familiar with us, where our geographic footprint is and what the makeup of our system is. I think, again, most people know we do three main things at PJM. The first and most important is reliability, making sure that the power system -- and I'll say "power system" instead of "transmission system" because while a lot of our authority is in the transmission side of it, the fact of the matter is we actually run a power system, not just a transmission system.

Second, we do do market operations. We bill out over $30 billion, with a "B," a year, so

there is a lot at stake, and this where cost allocation, in particular, gets to be quite a concern with the dollars that we are talking about. And then the last part is we also do the 15-year regional transmission plan for our area of the country as well.

So let me just hit the top challenges that we are seeing in PJM, and I think the good news is I think you've hit on all of these at some point this afternoon as you've talked. The first is on electricity demand. Our system, like everybody else, we are projecting sub-one percent growth going forward, and, in fact, we do see scenarios where we would see negative growth either due to some of the efficiency gains that we're seeing or through distributed generation. The negative growth would be on the wholesale meter side, so while the actual load may, in fact, grow, there is obviously the concern at the wholesale level we could, in fact, see negative growth at our level.

We're in the middle of probably the

biggest fuel switch we've seen in a long time. We were predominantly a coal region, and obviously the recent environmental rules and regulation changes has impacted our footprint significantly. We've seen a large amount of coal retirement. The good news for us is we also sit on top of Marcellus shale and Utica shale. So far, we have seen a huge increase in our gas resources as well, and it's been a win-win for us at least from that perspective in that we've been able to make this transition probably a lot easier because of the situation with natural gas.

Now, while that is the good side, this winter the polar vortex I think has taught us a lot of lessons as we become more reliant on that forecast and the interoperability issues with natural gas that we are facing. There are probably some huge challenges that we'll have to change and adapt as we move forward and become much more dependent on natural gas.

The next one is, and the one I'll probably focus on in my short period, is in the

integration of intermittent and demand-side resources. I'm going to focus mostly on the intermittent in the next couple of slides as I talk about at least one issue we think is ripe for discussion particularly for this group to deal with.

We're seeing not a lot of challenges now, and it's more about what we think we will see. We don't have a duck curve. We don't have the penetration other parts of the country have. But this is an area we think we can get ahead of, and we can allow the type of integration that potentially can happen.

Demand side resources I'm not going to talk about. I'll be happy to answer questions, but if you haven't followed, we just received a very interesting order out of the courts on demand side and ultimately what that may do. We've had a lot of success in demand side. It'll be very interesting how it plays out. I won't have a lot of answers right now as to how ultimately the court order will impact, but that will be very

much up to FERC and what FERC ultimately decides to do on remand and/or re-hearing in that particular order.

And then the last one for us is natural and unnatural disasters. Obviously from natural disasters, weather-related, we've seen hurricanes, earthquakes, tornadoes, deratios, super storms. It seems that the weather is getting more extreme. We have had extreme heat in September and snow storms in October, so we're seeing all sides of it. And then unnatural disasters is obviously the Metcalf issues and things of that nature when we're looking from a physical issue, potentially terroristic acts against our grid.

So moving on, this is just a slide to show you, again, the changes in our system, the biggest being that fuel switch. You'll see gas is, in fact, looking to outstrip coal as our biggest supply going forward in the near future. You can see historically that has not been the case. But also you'll see the increase in demand response and solar wind on a very steady incline

for wind and solar. Demand response has seen a little bit of tapering, and again, we'll have to see what happens going forward.

So one issue I did want to bring up as far as what we can do going forward, and this really is in relation to the renewable integrations. And one of the things we're looking at is in pushing through at least our processes in our stakeholders it the use of smart inverters, four quadrant inverters for solar. Now obviously for us we're going to look at it at a transmission level, at a utility grade level. That is what we have sort of jurisdiction over, but obviously I think it's applicable down at the distribution as well.

I think most people are familiar right now with inverters because of the current IEEE standards and stuff. The conventional inverters are just basically pushing real power in at a unity power factor to us. And in some cases why that could be good and in many cases it can be good. What we're looking at is the ability to use

these resources, I think, as many people have said. And I think Matt's presentation alluded to it as well.

These resources could actually be very helpful to the grid. If we were allowed to use the full capability of the inverters, both from a real power and from a reactive power perspective, we believe there is and can be a lot of support where these devices can, in fact, operate in all of these quadrants, potentially teaming solar with battery storage on the real power so that they can both produce and, in fact, bring in real power as well as the reactive taking VARS in and VARs out.

You'll see the picture on the side if you're not familiar with the Public Service of New Jersey's pole top solar installations. There's 280,000 of those out there. They do have two-communication, in effect. This is, again, a resource we would see that would be very useful.

I left this slide in Terry's deck, not because I thought I needed to explain reactive power to you. I just like the beer analogy, so I

figured I'd leave it in there. I think it's funny. Terry uses this in a lot of presentations he does where potentially people may not understand active versus reactive power. I think it's just neat to look at the beer in the afternoon.

So this is one of the problems we're looking to solve. Now, this is in Germany, and I apologize, I don't actually know the source of this graph. But the red line is looking at how the solar inverters actually respond today. And based on the regulations that they had in Germany at the time, the solar basically gets off the system at 50.2 hertz. They're programmed that as soon as the frequency hits 50.2, they get off the grid.

Now, interestingly I heard somebody explain this to me. When I asked why, they said it was actually a maintenance issue, but they wanted to be sure that when they work on the distribution circuit, the solar was off. So they'd actually go in there with a generator,

crank the frequency up, trip them before they work on it. Now, I don't know if that's a true story or not, but that is what they said.

The unintended consequence if that was what it is, is with the amount of solar that they have now, they're actually seeing these kind of frequency deviations where if the frequency gets that high at 50.2, which is not that high, all of the solar panel basically together simultaneously trip off. You'll see what happens is that as that happens, the frequency drops all the way down to 49.4 where they go into a low frequency.

So from a grid perspective, you went from a slightly high frequency to now a very low frequency. That is not the condition you would want. And at worst, then as a grid operator you are responding to that low frequency, and you're now bringing equipment on to bring that frequency back up. As the frequency then starts to creep back up, all of the solar panels then all of a sudden all jump back on at the grid. Unless there's a cloud plastering on, they all jump back

up. You go right back up to 50.2, and we do this all again.

That is obviously the problem we want to prevent. Now, again, right now the levels we're seeing, this is obviously not a problem. Our issue is we want to get ahead of this. What we're looking at is the blue and green lines where, again, through the inverter technology, you could actually have the inverters help control the frequency or help control the voltage if we're talking about reactive where, again, rather than just being this binary on and off, they can actually contribute to support and maintain the appropriate voltages and frequencies that we wish to see.

What we're doing about it and how we're doing it is we have interconnection standards right now for synchronous generators. When a generator connects to our grid, they are required to have automatic voltage regulators in place and in service. They have to obviously respond to frequency deviations. They do have droop control

functions that have to be modeled and meet appropriate standards.

What we're looking for, can we apply basically the same thing for a synchronous generation. Through looking at the inverter technology, can we look at some of the same characteristics and create an interconnection standard that take into consideration these factors, and very much as we put the standards on our synchronous generation, can we, in fact, do this with the generators?

We started a working group. Our hope is to actually file something with the FERC in the fall, this timeframe, where, again, we believe we can come up with these type of standards very comparable to what we see on the synchronous generation side, and on the wind side as well.

One of the reasons we're looking at this is just looking at what our alternatives are. If we are, in fact, have to compensate and deal with the inverters and the way they're currently set up, you're really looking at some very not

cost-effective solutions. It's going to require us to basically bring synchronous generation on that is fast responding, able to move. There is a cost associated with that.

The more generation we bring on just to sit there and spinning, the more we suppress price, depress price. We've seen certain areas of our footprint actually going into negative pricing in some areas. And again, at the end of the day, ultimately there's only so much you can do, and we would end up having to limit what could actually be supplied. That is not our goal. Our goal is to be fuel agnostic, and obviously we want the markets to ultimately decide how to produce the energy.

So again, we really feel we can be proactive getting ahead of this at this point. Our understanding from talking to the manufacturing is that this technology is already there. It is already in the inverters. They are fully capable to do that at least our level that we're talking about, utility scale generation that

is talking about. But even at many of the distribution levels, most of the manufacturing basically tell us they have to dumb down their devices, in fact, to comply with their current flow. So again, we think there's a huge potential there for us to do that.

So again, just to sort of summarize this, again, we think this is something the industry can get behind. We're looking at actually how to value it. Now, one of the interesting things for us is we do pay our synchronous generators to provide reactive support. Schedule 2 of our tariff actually allows our generators to file their costs to provide reactive support to the grid. We collect those costs for the generators and refund that.

We want to look at very similar mechanisms as well if there is a cost in this. If there is a lost opportunity cost in this to provide reactive power, can we find a way through our markets to compensate for this? We're working on some of that now.

Again, we believe we can substitute speed for inertia. I agree with Steve, we're seeing a very different fuel mix, and we know that, and we can address that. And we're going to deal with this at the transmission level. That is sort of what is in our bailiwick. We do see that this is really obviously at the distribution level as well. We're working with many of our states to see if we can't get them to adopt as well some of these particular standards.

And with that, I look forward to questions.

MR. GELLINGS: Thanks very much, Mike. Carrie, wrap us up, please.

MS. HITT: Sure. First, thanks for having me here today, and I have to say this is probably the most refreshing panel I have been on in all seriousness. I work obviously in the solar industry, and typically it's all problems and challenges and, you know, the undoing of the utility industry. And it is good to hear that there are people thinking about the solutions and

not just the challenges. So thanks for having me. I really appreciate it.

First, just very quickly, SEIA is a national trade association. We have about 800 members that represent the value stream of the solar industry -- installers, manufacturers, finance companies. And they're also all sizes, so large companies, big companies. And finally, our members work on residential, commercial, utility scale systems, so really the whole gamut of the industry.

I thought I'd just talk to you a little bit about what really is happening. Obviously was we've already heard and many of you have experienced, or seen, or witnessed, solar installations are growing dramatically across the U.S., and they're growing for every sector -- utility, non- residential, and residential systems. We still have concentrated solar power coming online. I think there's some expectation that that may change in the future, but right now it is a significant contributor to the overall

system installations.

So right now in 2014, our estimates for our last report, I think we're already at 1,900 megawatts of installs as of the end of April, maybe early May.

Again, 20 gigawatts, lots of PV and some CSP are expected to be online by 2016, so that would be getting us up to around 13,000. So significant growth expected to continue in the next few years.

And then again, just showing the variation across each of the sectors what's happening with prices. I think someone referenced this already, but this is our analysis on what's going on with price systems both for residential, commercial, and industrial systems. We're looking at $1.77 a watt right now for utility scale systems.

Now, I should mention that some of these will be slightly impacted by a trade case that's going on if anyone is paying attention to that. You may see a little bit of bump in terms of

hardware costs, but that's expected to go away over time as solutions are worked through.

A couple of people talked about small penetration, you know, a very limited number of percentages of installation. And it is still a very limited number of percentages of installation. And it is still really a really small slice of the pie in each of the states, and this is just sample of how much you're looking at. In, you know, a place like Arizona, it's probably at about five percent of total penetration right now. In Massachusetts where I reside, while we've had significant growth, it's a fairly small percentage of the overall consumption. But, of course, as our previous slides referenced, it's growing dramatically.

I thought I'd talk about California just a little bit because we've referenced the duck curve, and that is an example of some of the challenges that are happening as we've had more solar installed. So here's what see in California. Historic installations and that is

driving down cost, and one begats the other, of course. And we've seen dramatic declines in costs.

And I know this is a little detailed, but again, you just see the trends here in terms of average prices in the number of installations over time with the prices being kind of shown in the orange and green, and the installations in kind of the bar chart area. The forecasts again for California is dramatic growth, getting to 55, 100 megawatts GC by the end of 2016. And I should say, although this may not be as relevant for California, I don't believe these forecast numbers take into account any implications associated with the EPA rules that are in process.

So the duck curve. People have referenced a duck curve today and really what does that mean? And I wanted to take my time today just to talk about some of the solutions that are being proposed for the duck curve. And I am going to steal from RAP a lot today, so I apologize, but they really have done some of the best work, so

I'm looking at Rich Cowart to mention that.

Yes. There is an issue in California in terms of when solar is on, the ramping up period, when demand peaks in California, and that's true in a few other places as well or it could be true. But I think even in the past six to nine months, we've seen some good conversation about potential solutions for that challenge.

First, I think upon further study, folks realize that ramping issue is probably less severe than the first analysis showed, although it's still an issue; that flexible gas dispatches can help that; regional cooperation, reference by a few other folks can help smooth those ramping issues. And ramps are, of course, 100 percent predictable, which is helpful. So we can talk about these things and come up with solutions for them.

Here are some of the solutions. I'm going to give you a bullet chart, which I think is a little bit better, and I'll go back to that after.

So as I said, I stole from RAP. The Regulatory Assistance Project did a report on this and a webinar I think maybe last month or the month before. And they laid out 10 strategies for mitigating the situation in California, and they're pretty broad-based.

But first, target energy efficiency to hours when the load ramps up sharply. And of course California is one the leading states in energy efficiency programs, or in fixed assets, solar panels to the West. Substitute solar thermal with a few hours' storage. Implement service standards allowing a grid operator to manage electric more effectively. Require large air conditioners to include two hours of thermal storage. Retire inflexible generating plants with high off peak and must-run requirements. Concentrate utility demand charges in the ramping hours to enable price-induced changes in load. Deploy electric energy storage in targeted locations. Implement demand response programs, and use inter-regional power transaction to take

advantage of adversity in road resources.

So those are the number of recommendations that they put on the table. Of course, these all have varying costs and, you know, whether or not you can actually do them will vary. But I think, A, they're applicable to California, and, B, we can learn from those lessons and those recommendations and take them elsewhere.

The situation, while, you know, in California similar things will happen in other markets and other states.

We've also been talking about Texas in a different way, which is Texas has some issues in itself, and I just wanted to show you these comparisons today. So Texas is talking about resource adequacy and reliability, and they, I think, most people will have growing load unlike other markets in the country. They have water resource issues, and potentially in the future will need new generation certainly sooner than some other markets.

And we're suggesting that solar is part of that solution. Texas has a great solar resource because of the radiation because of the growing load. I don't want to say we're working with ERCOT. We're recommending that ERCOT change how it calculates capacity value to include solar in that mix, that ERCOT should include utility scale and distributed generation in its resource planning. And we would argue this is applicable to other markets as well. And that ERCOT should establish future ancillary service requirements that enable solar generation to participate in the ancillary services market.

So, yes, I picked on Texas today and California, but I'm doing that just to give you some examples of some of the things that are happening in real time, practical conversations that are going on in addition to some of the technology solutions that other speakers spoke about.

I wanted to be brief today. I'll just close by saying one thing. I know that prior

panel dipped into this a little bit. I purposefully did not get into rate design and rate-making challenges, which are, of course, going on in nearly every state as it relates to distributed generation. And I think we, at least, at SEIA would share the view that looking at rate design and how rates are structured is really critical to the future, not just because of what's going on with solar DG, but what is going to happen with electric vehicles. What is that next appliance that's coming on?

There's always something coming, and we need to start thinking about changes and making not only our grid more flexible from a technology standpoint, but thinking about rate design, not only how it can accommodate these resources, but really making sure that cost sharing and benefit sharing is equitable across all rate pairs. So thank you.

MR. GELLINGS: You're welcome. Very helpful contribution. Rich, can we take 30 minutes?

CHAIRMAN COWART: Yes.

MR. GELLINGS: Okay. All right. Merwin, I cut you off before. Go ahead.

MR. BROWN: I'm broadening my question. That's your penalty for cutting me off.

As I listen to what's being said here and what was said earlier, an old issue comes back, and that is, is the grid there primarily for societal purposes, or is it there to enhance market transactions? And when I also hear the talk about, rather glibly, that we need certain rates or we're going to use instead markets to determine things, we end up with what we have today, which is a hybrid of both.

And I sort of feel like it's trying to balance a marble on a bowling ball because it's going to roll one way or the other. I don't think it's going to stay there, but maybe I'm wrong.

And so, with that in mind, are there any thoughts from the panel of how this sort of deep societal aspect of the grid is going to play into all of this? Are we going to have to go one way

or the other, are we going to continue with this hybrid approach? Should we even worry about it?

MR. LARSON: From the West where we have only one organized market, we're going to end up with a hybrid approach as far as the eye can see. And I think we have an example in California where there's a reluctance to go to a capacity market because California has specific not fuel neutral goals. They're very fuel discriminating goals. And they really aren't anxious to turn that over to FERC to a fuel-neutral party that might screw up their energy policy.

MS. HITT: Speaking for myself, I do not do a disclaimer, but I think the grid is used now for many purposes. It is to promote certain policy initiatives at the state level in some ways, and we may all see that even more so in the next coming years with new environmental regulations.

I think the other change, although I've seen it before, but it seems more real this time, is that customers are -- not every customer,

certainly not every rate payer is more engaged at this point. But that's not, you know, I would never argue that at this point. But we are seeing, you know, customers actually want things and want things that are different that do utilize a grid. And, yeah, maybe they're assuming it's going to be there, and that's not the best assumption, that they're taking it for granted. But they're going to assume that they can use it and, you know, tap into it. And, you know, maybe they'll have to pay costs for that, and that's okay.

But I think that's a big change than maybe where we were 20 years ago.

MR. GELLINGS: Thank you. Dr. Heyeck?

MR. HEYECK: Yes, mike Heyeck. I affectionately call him Dr. Gellings because I'm not as worthy as he is for that title.

Photovoltaics has really been a game changer, and I think many of you spoke about that. And I truly believe that that will be the mainstay of the game-changing element in the next 30 years.

But what's going to make it much more powerful is storage, and storage is a way to deal with the load curve. We have a lot of opportunity in the grid today given the load duration curve. It's still a phenomenon that we don't enjoy the benefits of. We have that 60 percent load curve. I think we could use photovoltaics and energy storage very well.

Modular nuclear may be an option in the future. Who knows? I think, Mike, you said this about gas. Reliance too much on gas is going to be an issue, so we do need some other sources.

The bottom line for me is the resilience of the grid will be the diversity of the sources we use whether it's distributed or central, whether it's gas or photovoltaics or whatnot. I believe that the diversity of the resources gives us many more options should one of those elements fail. And I think that that is something that the QER ought to consider in its strategic outlook.

MR. GELLINGS: Is there a question in there for the panel?

MR. HEYECK: Yes. The other side of this is the customer, and I would like to understand how the customer would view their electricity usage 30 years from now. Certainly we know the Wal-marts and the industrials, but the residential customer, who's going to manage their photovoltaics, their storage, their elements for energy usage?

And I'd like to get just a customer perspective rather than the technology perspective from whoever wants to answer on that.

MR. GELLINGS: Mike, are you going to answer that one?

MR. KORMOS: Yes, I'll give you an answer. I don't necessarily have a good one. But, I mean, I think if you look at the next generation, they're so much more technically savvy than we are. Their expectations of having that control I think is just going to be significantly better. So I do think fundamentally a lot of times we make the mistake. We're looking at our generation and what we want as a customer. And

you're right, in some cases we want hands off. I don't think that's the next generation. I think they are much more comfortable with technology, and not even comfortable. It is an expectation for them that they will have that, and with that technology gives them the control.

And I do think another question, you know, they'll want to choose how they want to interact. I think, you know, that is going to be a fact coming up. I realize it's not today, but I really think, and I'm not an expert in this, but we've talked to some people really trying to look at what the customer's desires are going to be 30 years now. I think it's fascinating because the next generation is going to be very different than us.

MR. GELLINGS: My old cell mate, Mark Lauby.

MR. LAUBY:: Thank you. I just wanted to mention that NERC has recognized this issue when we do our long-term reliability assessments. And recently released a tutorial for policymakers

and rule makers on what we call essential reliability services. And there are really six of them, and they include operating reserve, frequency response, active capability, active power control, reactive power and voltage control, and disturbance performance.

The take-aways from the tutorial really are that not all megawatts are created equal. It used to be they would have a certain reserve margin, and we would get inertia. We would get, you know, frequency response. It would all come in with that reserve margin, and that is not the case anymore obviously because one megawatt is not the same as the other.

So, you know, we want to start thinking about, well, how do we measure the kind of flexibility one wants in the system so that we can actually get to the second take- away, which is the physics so the systems remain pretty much constant, you know, that you need to have voltage and frequency and load resource balancing. And, you know, you require these essential services to

do that.

And then finally, of course, this changing resource mix, we have to keep this in the forefront of our minds so that we design systems that can accommodate the large amounts of this kind of technology and resources and still remain reliable.

So we have an ongoing effort and interested in the perspective, especially from PGM as you see more and more of these different types of resources coming on your system. Have you designed some measures for the kind of flexibility that you want in your system, and how are you planning that in your system?

MR. KORMOS: Well, if I could give you short-term answers and long-term answers. I mean, short term we are taking a hard look at things in our capacity market, performance standards that we want. We're looking at gas interoperability. We're looking our reserves. We're looking at some of the ramping issues with an overlapping 30-minute reserve product potentially. There's a

lot of short-term answers.

I think long-term -- I'm going to sound like a broken record -- I go back to technology. All this becomes moot if we had storage. Then everything goes back to megawatts. I had a great conversation with Chris Shelton a couple of weeks ago. We talked about could the power grid ever get to be the internet. Can you ever develop enough storage and enough power electronics that you create the power rather of the future?

I would go back to the public service because the internet probably provides as much public service as the electric grid. Yet nobody manages it. Nobody has to go through an interconnection process if you want to put a data center on it. But a lot of this on the storage and the technology side that allows that grid to operate fundamentally different than ours.

So I think long term, I think technology may give us a dramatically different answer, but to your point, short term, everything you just talked about we're looking at.

MR. GELLINGS: Thank you, Mike. Do you want to add something, Steve? Go ahead.

MR. BEUNING: Yes. I just wanted to add onto that because we may reach that point sooner than Mike thinks or maybe you did think about it. But we're approaching 30 percent annual energy supply for our customers from renewable energy sources by around 2020. What we're seeing is at that level of annual energy supply, we might have a peak hourly penetration of renewables around 60 percent of our total retail demand in a given operating hour.

And that sounds high, but if you think of the way the future might roll out if folks decided to go away from carbon all together, for example, or something. You had, say, a 50 to 80 percent annual energy expectation from renewable resources, you're going to have many hours a year where your demand is the dispatchable element, and you're going to be curtailed on your supply side waiting to ramp up latent supply as demand can consume it.

So, you know, the negative prices that we see today that get driven by situations where dispatchable units can't be de-committed, for example. I think there will be a period of time before storage comes to the solution where we'll see the need for demand on demand, and we'll start creating price signals for the development of storage technologies or something like that.

MR. GELLINGS: Thank you. Richard?

CHAIRMAN COWART: Well, first, thanks to the panel for the really in-depth observations about all these problems. As some of you know, I work predominantly in Europe these days, and we're having the same conversations in Europe as are being had in this room. And there is -- can I be heard? Is this okay? With one difference. Most of the conversations in Europe would begin with the observation that environmental sustainability is a goal and a given, and that the rest of this conversation is about how do we achieve that.

And I've been intrigued to observe the various presentations and conversations that don't

begin with that as a premise. It's sort of to say, well, sustainability is one of our goals, or it's an objective to be obtained if we can get the pricing right or something like that. Just making the observation that I think a decade from now if we were having this conversation, the U.S. conversation would be a lot more like today's European conversation.

And to that end, I guess I would observe, and thanks, Carrie, for talking about the duck curve. There are really good answers with respect to the duck curve involving all the things we know about demand response, et cetera, et cetera, et cetera, that we've learned over the decades. And so, I think that, yes, it's a problem, and, yes, they can be answered.

And I'm going to close with a question about the proper allocation of costs because it's really interesting. I'm a former regulator. I'm a total believer in the proper allocation of costs. I'm also a believer in the proper allocation of benefits and paying for value. And

so, it seems to me that this is a bi-directional problem. This isn't just a question of how much should customers pay utilities for providing any number of grid-provided service, but also how much is the customer's demand response activity or distributed generation worth to the grid? And it seems to me like we're going to have to evolve a bi-directional rate design and not just think about it as a one-way street.

So my question to the panel is, do you agree with that?

MS. HITT: Well, yes. I guess I would just say that, yes. I mean, that's one of the things that we saw early on in this debate which wasn't even that long ago, but now seems a long time ago, was that there was a lot of rhetoric and kind of people got exercised over this issue, was that the proposals that were coming out of some utilities or kind of others were just looking at what they saw as costs.

And so, you know, our response to that has been for the past year to say, sure, there may

well be costs, but there are also benefits that both the grid and other rate payers are receiving. And so, a real look at all those component parts is absolutely necessary, and also it's not just a solar DG issue now. There are other things happening on the grid at that level that changed the cost benefit analysis.

So looking at it through lenses, and that's putting it simply because I know it's complicated is probably the most important thing we can do.

MR. GELLINGS: Thank you. Rich, I can't help it. Your comment leads me to say it's an engineering problem, and I'm an engineer. We can solve this. Did you want to add something?

MR. LARSON: Just one response. There is a limit to how much utilities can charge, and that's when it becomes economic to leave the grid. So Steve at some point may buy the battery and leave the grid.

MR. BEUNING: Yes. My escape fantasy may be realized, huh? I just think, too, that

when we talk about benefits, there's two parts to the benefits that we're talking about. I mean, there's the energy production and consumption side benefits -- you know, do I burn fuel or do I generate from PV? If there's a regional market that's providing that for me and I'm not satisfied with the costs on that part of my allocation of costs and benefits, I can go self-invest in something.

Where I have less flexibility is with respect to the grid and the backup services the T&D provide. And what we tend to see there are a regional type policy that deems benefits to have been provided. And personally as a customer subject to regional transmission cost allocation, I have some concerns with the early stages that we're at right now, the use of adjusted production costs, for example, to infer absolute benefits to me may not be realistic.

I might've been 90 percent of the generation in an area that had an adjusted production cost benefit calculated, and I may have

been at the bottom of the dispatch stack every hour of the year. And that adjusted production cost conferred no benefits to me as a customer at all, and that's something we're seeing, for example, as a technique that's used in regional technologies today for the allocation of transmission costs.

So we have a ways to go on some of the philosophical underpinnings for how those benefits get determined and allocated.

MR. GELLINGS: Talk to Steve about the Minnesota cost of solar study if you have a few minutes over dinner. Pam?

MS. SILBERSTEIN: Thank you. Maybe this picks up on something you just said about having perhaps less respect for than you might have had previously for the T&D infrastructure. And thinking about other industries, for example, telecommunications. There's this proposal that's been put forth for net neutrality or changes to net neutrality.

And I have been thinking for a while are

there parallels to those proposed changes to our industry? Now, I'm not a telecom person by any means, but as I understand it, should we be looking at ways you're going to pay a premium for highest reliability. You willingly pay less for less reliability.

I think one of the concerns certainly about the cost allocation and cost transfer is that concern about being the backstop and the default. But if that's not there, then maybe there are ways to allocate those costs differently so that, you know, that people who willingly do not want to have to rely on the backstop of the grid won't have it available.

MR. GELLINGS: Red, blue, and green kilowatt hours.

MS. HITT: I think, yes, maybe there's a way to think about it that way. The challenge, which you're all probably much more familiar with than I am given what I do, is simply the association that we have with the electricity service with not our livelihood, but our lives, I

guess I would say. So, you know, in many cases, having access to your phone and to the internet is critical now, much more so than five years ago, at least for internet service.

But electricity is viewed slightly differently, so it's hard to get from this point to that point without something in between, I guess, and that's the challenging part I would say is people want to cling onto that.

MR. GELLINGS: Steve?

MR. BEUNING: Yes. Well, if my comment was inferred as not having respect for the T&D, please amend that accordingly. But, you know, to some extent what you're talking about what in the proposal that we just saw from PNNL for example. If you have demand that's price responsive, it's making a choice at some level with respect to that decision to participate or not.

On the generation side of the equation, today a generator in a regional wholesale market can simply elect interconnection service and bet at a subordinated delivery priority to other firm

uses on the grid. It's an operational problem to administer curtailments in a large regional market and to track that prioritization of use.

And what we're seeing in markets like MISO and SPP where there's currently a dispute about how much impact one can have on the other, even at that level of coordination, operationally it's complex and difficult. And if we extend that to a million retail customers, each with a different level of assurance payment that it's making for backstop capability, I think it becomes an operational difficulty. I' not saying it's impossible.

MR. GELLINGS: Thank you, Steve. Tom?

MR. SLOAN: Tom Sloan, and thank you. Two things. One, each of you qualified your statements as that you're not speaking for your organization but as individuals. Because I assume most of you don't know another state legislator in this country, I am speaking for all 5,000 of them.

Seriously, I'm going back to what Ron Melton was talking about when he set sort of the

stage for this panel, and from the decision maker perspective. He and the GWAC folks are trying to set the framework to describe what each of you talked about in your own segments. And so, I would want to encourage you to look at the model, look at your daily activities, and see whether the model is kind of capturing it on the large level. The same thing for the EAC members.

But within that context, keep in mind that the regulatory community and the policymakers, whether they're governors, or legislators, or whatnot, can get easily confused if you're all using different words, or different pictures, or different whatever to describe transactions and relationships. So whether the GWACT model is the answer or not, try and work toward reaching a consensus. That way, the Department can frame its activities in a way that utilities, RTOISOs, legislators, you know, all God's children can understand, follow, and move forward. Thank you.

MR. GELLINGS: I didn't hear a question

in there, so I'll go on. Carl?

MR. ZICHELLA: Since Tom's speaking for all God's children, I guess I'll speak for an environmentalists here. Seriously, I think, first of all, this has been a fabulous panel. Thank you all so much. I think that a lot of what we've been talking about and thinking about, you've given us a good perspective on, and in some ways underscored some things and shook us up on some others. Doug.

But a couple of things I thought were really important to me when you look at these balance portfolios that we were talking about earlier, and Carrie put up the RAPs, 10 ways to make the duck fly issues. You know, a couple of these things around regional coordination and generation stack, we're in danger of losing some of the generation options to us, like concentrating solar power, which was mentioned, where we have a technology that buys you time in the evening ramps. And if you combine that with some thermal storage, you actually operate a lot

more like any other power plant at all.

And because we're not pricing the technology for its values to the system, we're really making it difficult for these projects to get financing, to have the room to remain in the generation stack. I just was at their annual conference in Las Vegas. This was a big topic there about how to have these services, these grid services in addition to the energy be recognized.

I believe NREL just did a study that implied that there's about a four cents a kilowatt hour benefit to CSP that is not being captured in the pricing for the technology. California Public Utilities Commission has actually approved a couple of power purchase agreements that were above what you would pay for a PV, for example, to capture some of these benefits.

But I wanted to throw it out there. I thought the point that Richard made about the allocation of benefits and value, benefits cost, but value, and capturing that is really important, just as it is in the demand side management market

as well.

But as we look at the characteristics and attributes of these various renewable energy technologies and their ability to complement each other, we need to do a better job at valuing that.

The improvements in the operations and wind turbines and ability to product reactive power, for example, another good example of that where it may not be fully recognizing those benefits. And, of course, the geographic diversity of that that Steve talked about. And the ability to just utilize those characteristics and generation profiles.

So it's not really a question. It's just a comment and a thank you to the panel.

MR. GELLINGS: Since there's not a question, I'm going to go onto the last two. There will be no more. Marilyn first and then Wanda. Marilyn?

MS. BROWN: Okay. Richard, I wanted to thank you for your fresh perspective from your European experience about the importance of

environmental issues going forward. Being so dumb, I'm kind of surprised that we haven't talked about the 111(d) yet today, and where that's going to take us.

And for Doug I have a question about don't you think that it might be breathe new life into the nuclear renaissance in this country which could meet some of your conditions for resuscitating the grid. Let me keep going for just a minute because I've got another question, too. You're saying resuscitate central plant generation. Maybe nuclear will be what does that to some extent.

And then on demand and response, we haven't had much discussion of its environmental attributes. What is the value of nuclear in this new world of CO2 constraint? What's the value of demand response in this new world?

Now, in and of itself I like to think of demand and response as being something like a carbon neutral safety net. In most cases it doesn't have a big differential either way. But,

in fact, it's an enabler of renewables, maybe somehow it ought to be given some extra value, and it's the value of DR. But I'm perplexed because you mentioned that for PJM, DR is shrinking or not done real in the past couple of years. I mean, Terry Boston was telling me a few years ago about that big water heater load that's being tapped into, I don't know, bigger water or something.

But then I hear out in California or the Western interconnector, I'm not sure what the area of coverage was. There's a five-gigawatt economic potential for demand and response. So what's going on with demand and response? Why is it shrinking in PJM? And could it play an important role in helping to enable cleaner resources? So that's for Mike. And, Carrie, you might want to chip in as well.

MR. GELLINGS: Gee, Marilyn. You're getting mean here. All right. Brief answers, please.

MR. LARSON: Nuclear option in the West. We in the West are blessed with lots of other

options, renewable options, so we're thankful for the guys in Georgia who are willing to experiment with the next generation and pay for it. And if it works, we'll be back. Our major challenge is actually keeping the current plants operating. We just lost San Onofre.

MS. BROWN: But that's from a California perspective anyway.

MR. KORMOS: On the demand side, this probably goes back to the last couple of speakers, I think our biggest struggle is to figure out what are the services we are trying to provide, who is providing them, and who is consuming them. And right now we mix them up a lot. And I think that gives us very unfortunate consequences, and demand side has been a classic one.

It should be on the demand side of the equation. You should get the value by not consuming and not having to pay for it. But because of all the public good and the great good, we've moved it to the supply side, and it just has come with a host of issues as how to measure it

and how to verify it, how to accommodate it, how much you can. I think for the industry to move forward, we have to push it back to the demand side.

The value is there, I don't disagree, and we have to get the pricing of the products right so people see the value from the savings they get and what they don't have to pay for rather than trying to continue to treat it as this pseudo supply option.

So and we have a court order that may, in fact, force us there. Again, we don't have the answers at this point, but we have a court order that may push us back there.

Why demand sort of tailed off a little bit? I actually think that was just very natural. We went from 2,000 megawatts to close to 17,000 bidding in our market within three years. There may have been some natural exuberance there. As people started to realize the challenges of actually getting that, we've seen a little bit of a decline.

MR. GELLINGS: Wanda, last point.

MS. REDER: Yes. With IEEE, I'm interested in standards. And my simple question is where are the gaps? There's been some references in terms of metrics. Diversity might be resilience, language. There's all kinds of innuendos around the standards theme.

I'm wondering from your perspective where the gaps were, the challenges on the standards front.

MR. BEUNING: Well, 1547 has been mentioned. To me, that's the bull in the China shop right now. I mean, I don't know if it's completely, but opposite standards at the bulk level versus the distributed.

I think there are other issues, too, with respect to efficiency of utility operations that are at least high on my personal radar. The BAL standard, for example, which relaxes the degree of balancing control that utilities provide, which historically was set primarily to enforce equity with respect to unintended energy

transactions between utilities that were each supposed to take care of their own obligations, and has been preserved, you know, in the old A1 and A2 criteria that got preserved into what is now CPS 1 and 2 standards, an attempt of keeping unintended transactions limited.

The new replacement standard would allow a great more latitude for utilities to only incur balancing costs when it was necessary for the sake of reliability. And this has been, what, eight years in the field trial so far? And we just can't get the critical speed to get over the speed bump. So that's been my person axe to grind. I think there are some others with respect to the frequency response, for example, and the challenges of increasing inverter connected generation, the impact that might have on frequency response are kind of big on my radar.

MR. GELLINGS: Throw some mundane stuff in there like IAC 61850, and we still don't have the communications to sort it out yet, but whatever. Can we thank this panel for an

excellent contribution?

(Applause)

MR. GELLINGS: Mr. Chairman?

CHAIRMAN COWART: Thank you, Clark. We've now got just a few minutes. We'll take a break around the top of the hour. We have a few minutes for discussing the Power Delivery Subcommittee papers and work plan. I apologize. We can take the break now. We'll back in 15 minutes. That's five after the hour.

(Recess)

CHAIRMAN COWART: I know we're having fun, and yet we need to reconvene.

So our next item is a discussion of the Power Delivery Subcommittee's upcoming events and work plan. And David Till is going to lead us through that.

MR. TILL: Thank you, Richard. I hope you enjoy the Power Delivery white papers and work plan because you've been participating in it for the last little while in the meeting here. We decided to have the panel, at least the first

panel, on the 21st Century Grid prior to drafting the white paper. And there are only two things on the work plan for the Power Delivery Subcommittee for this year. The first is to work with Wanda Reder's smart grid team on an R&D paper, and Billy Ball and Clark Gellings have been doing a good bit of work in drafting that. And we've been providing what comments that we could because there just wasn't anything we disagreed with. And then the 21st Century Grid white paper.

And you've got an outline in your materials. The basic outline is background on the need for modernization and expansion assessing need, build new transmission or enhance capacity on the existing system, and then recommendations for DoE. And it's very important.

I don't believe that we're going to have a hard time drafting the white paper. We've got some really smart people drafting the white paper, and we can get a white paper in place. But driving to recommendations on the right research for DoE is going to be a challenge to get by our

September meeting.

And as you know, the research projects are extremely viable. I'm not as smart as you are. I grew up keeping wires in the air and transformers humming. But at the point when I made the transition into management, I was responsible for commissioning the first fax device on the grid, the STATCOM unit at Sullivan Substation. And it formed my thoughts in so many ways.

First of all, I was drinking out of a fire hose, and here was this device that I knew nothing about. And then as I got time to look at it and to consider the reliability, and attend EPRI meetings along with AEP, who was putting in a unified power flow controller at INEZ about that time, and the other people who were interested in these projects, and we were talking about reliability, and new technology. We were trying to drive it higher and higher into the 90 percentiles with our reliability.

And then it hit me out of the blue that

doesn't mean a thing for me. We applied this device to mitigate voltage collapse. And I don't care if it's working any other time than when voltage collapse is threatened. And as I drove the people working under me to learn more about this because I wasn't bright enough to, and to distill this for me, we came to an interesting conclusion. And that conclusion was our device would never work.

And the reason it would never work was not the high tech of valve hall and all of the sexy electronics. It was the station service. This was the first device we had ever applied in one of our substations that didn't work off battery when the lights went out. And the station service to this device was inadequate.

When the transformer failed that set up the threat of voltage collapse, it took away the primary station service. Secondary station service depended on the very bus that the device was supporting. Was it fast enough to save itself? It was as fast as greased lightning, but

it wasn't that fast.

And so, then began an attempt to educate the industry because there one of these in Korea. They were all over the place in the United States. Ours was the first. By the time we figured this out, they had proliferated. And not only was it that technology, but it was going back to the SVCs before it. We didn't have one, but others did.

So was that a failure? No. That was the second most educational experience I've ever had. And as far as I'm concerned, it was worth the tailored collaboration money to get me that experience. The first most educational experience I had a VP tell me cost $321 million. The first corrected is math, and then I said thank you, though.

So what we're driving for is not just the excellent discussion that we're having here, but it's to in a direction with the R&D that we all support with the trust in each other that if we've gone in the wrong direction, we're all going to change direction together, or we're going to

learn from whatever success or whatever failure that we have as an intermediate failure.

So that being said, I thought it was an excellent panel, and I really appreciate Clark's moderating it. I appreciate the work of Carl Zichella and the Power Delivery Subcommittee in putting together the outline that's in your package. The outline somewhat invites you into our kitchen. This is a more family-oriented outline in that we've included elements of our discussion so that you know a little bit of what's going on in addition to just what the outline is, and that's a good thing.

So in a moment, I'll open the floor for your comments on that. But I just want to say that we're all going to skip tomorrow so we can write on our paper. No.

We have a challenge to not just get it written, but get the right content in it by September. And I haven't heard this yet. This may be going on in the background and I know about it. But for the new members of the Electricity

Advisory Committee, when you select your subcommittees, please keep the Power Delivery Subcommittee in mind. We have fun stuff.

So with that, that's all I have to report except to answer questions.

CHAIRMAN COWART: Granger?

MR. MORGAN: Thanks. That was nice. When I look at the outline, in the first section there's talk about 111(d) and what it'll do. There's talk about renewables. There's talk about low cost gas. There's nothing on nuclear, and I understand that low-cost gas makes nuclear even more difficult. And we're retiring single nuclear plants in part because of low-cost gas.

On the other hand, if I look a few years or a decade out, one, I'm going to be trying to reduce the carbon intensity of the whole economy by 80 percent or so. I'd probably want to continue to have some of those nuke plants around.

So I don't know if it's appropriate to include some discussion of the tension between, you know, this wonderful benefit of low-cost gas

and the fact that in slightly longer term, it puts a real stress not -- I mean, we have a few nuke plants being built, but they're invertically integrated utilities, and that's not clear to me that in any merchant market anybody is going to build nuclear.

And the facilities that have more than one plant look a little more healthy than the single plants, but we're losing them.

MR. TILL: Okay. That's a good comment. Thank you. Appreciate it, Granger.

MS. BROWN: We're losing them, but they do have another perhaps 20-year life expectancy some of them.

MR. BROWN: But some of the ones we're losing have life expectancy.

MR. TILL: Did you catch those comments? Good. I missed it, but that's not important. Merwin, is that your pen or it's Marilyn's?

MR. LAUBY:: I agree with you. In fact, when we looked at his, we looked out to 2050, and we looked at the 80 percent. Unless you have

carbon capture and sequestration, you can't get there with gas. And, in fact, gas, of course, it's a messy business when that thing gets in the air. It's also a more potent climate change issue.

So definitely nuclear is the only thing that can really be in the mix.

MR. TILL: Okay. Mike?

MR. HEYECK: I just wanted to emphasize a comment that's included in the outline. There's been a lot of discussion today, and I'd say probably 90 percent of it is are discussions about distribution, distributed resources.

When I started six years ago, it was all about transmission, and distribution was kind of the stepchild. Now it's the other way around. I just want to emphasize that when we started this paper, we were trying to get to that rational middle of no regrets. Whether it's include nuclear or what not, we're going to have wind farms. We're going to have offshore wind. Transmissions are going to be needed. So the

emphasis in the paper is not just distribution, but also transmission for the grid of the 21st century. And I'd say somewhere around 2050 is probably what we're talking about. I'm not sure we can envision 2100.

Again, I just wanted to emphasize. I won't be here to opine in the next meeting. I just want to make sure that we still continue to learn how to spell "transmission" and figure out the challenges and impediments and the opportunities with that.

MR. TILL: Thank you. Should I quit doing your job, Rich? I'm sorry.

CHAIRMAN COWART: No, you've been doing it just fine. There's one card up, so I'll take care of it. Oh, there are two cards up now. But, Merwin, you're first.

MR. BROWN: Thank you. Merwin Brown, CIEE. I had a number of comments on your outline. I had a lot of hours on a plane to read it and mark it up. But I had kind of three broad comments to make right here. One of them here, I

was confused in reading the outline in the sense that it seemed to be substituting or jumping back and forth among the words "reliability," "flexibility," "resiliency," and "security." And so, I didn't feel they were very clearly described in here, and they seemed to have mixed use throughout the document. Maybe I don't understand it, but I thought at least there was one person that was confused.

Another item is a suggestion and addition in the area of the outline where you talk about increasing the benefits of rights-of-ways and getting more value out of them. You talk about re-conducting and reconstruction. I would suggest also various forms of technology use for reducing the constraints from thermal constraints and dynamic instabilities because that eats up a lot of capacity, I know, in the West.

And then the third comment has to do with the replacement of inflexible gas generation with more efficient and fast ramping technologies. You focused on gas. I don't know that you

mentioned storage as being a fast-acting flexible thing, and it seems to me since I represent the Subcommittee on Storage, that that should be in there somewhere.

MR. TILL: Thank you.

CHAIRMAN COWART: Granger?

MR. MORGAN: Yes, sorry. I forgot one other comment. If you listen to people like Rick Denonker, who runs the E. On Research Center in Aachen, I mean, he's a believer that DC is just going to promulgate all through the distribution and transmission systems. I'm not sure I believe it, but at the same time, I guess there's maybe a little more discussion of if DC and, in particular, you know, DC transformers with -- well, of course, they're AC in the middle -- become significantly more affordable, one might want to consider a little discussion of that as well.

CHAIRMAN COWART: Thank you, Granger. Carl?

MR. ZICHELLA: Great comments. I just

wanted to bat the ball around the yard before you get a little too -- I was just concerned about the ideas around nuclear mainly because I don't think we fully look at the life cycle costs of that resource. We are talking a lot about new technologies and modular technologies. And even as we're decommissioning the existing fleet that is beginning to phase out of the system, slowly albeit, but it's happening. We have $4 billion set aside in California for decommissioning. It's not going to come close to covering the costs of doing that.

The Humboldt Bay nuclear power plant, which is 63 megawatts, is forecast to cost $1.02 billion to decommission. You know, we may only see vertically- integrated utilities going there, but that's part of the reason, you know, we're getting construction and progress for some of these facilities without which they wouldn't be built.

I know it's part of the President's plan. I know it's in there. We have to consider

it, and we need to have it in this document as well. So I'm just giving you my personal take on let's be realistic about what we're going to get. We may see the life extensions of many of the plants happen, but a lot of these technologies were not intended to last 60 years to begin with. The idea that their design life would extend that long without major overhauls, steam generators, reactor vessel heads, et cetera, et cetera, et cetera, pretty soon you're talking about complete reconstruction of a lot of these facilities. And that's not even touching upon the decommissioning of them as well.

So, yes, let's consider it. It needs to be in the mix. It's part of the President's plan. It is part of the landscape right now. We may see modular reactors. But, you know, when I look ahead, I also think the back end of the fuel cycle, too.

CHAIRMAN COWART: Mike?

MR. HEYECK: I just wanted to add to Carl's comment and Granger's. First, Carl. I

think there's got to be discontinuity. If we extrapolate the nuclear paradigm today, you're spot on. The issue is whether the traveling wave reactor or some modular element comes to fruition that would offer much lower life cycle costs. Don't know that. If we did know that, we'd have them out in the system.

And regarding HVDC, you're spot on, Granger. The voltage source converter technology that's come to fruition to offer much better undergrounding, especially in urban areas, will be very useful for transmission. A lot of times when we look at the transmission technology list, we see dynamic line monitors and PMUs. They're okay, but advanced conductor voltage source converters and other factors add to the transmission technology list. So I appreciate the comments.

CHAIRMAN COWART: Granger?

MR. MORGAN: So just one final comment on the nuclear issue. First, yes, you're absolutely right. There are a lot of costs. Second, on small modular reactors, I would not

hold my breath. I've published a piece in the Proceedings of the National Academy about a year ago that suggests that like water, small modular reactors, which are the first ones that'll come along, are just not going to be anywhere close to being cost competitive.

At the same time, I run a center called the Center for Climate and Energy Decision Making. I don't know how to get to an 80 or 90 percent reduction in CO2 emissions across the entire energy system without essentially a portfolio of everything we've got. And that's why I argue that though we all know the downsides and the hidden costs and so on, we don't want to rule anything out, or at least I don't want to rule anything out of the portfolio on the generation side.

Having said that, I mean, two-thirds of what we do is actually on efficiency issues because, you know, we're wasting more of the energy we produce than we're using in a useful way.

MR. ZICHELLA: And if I can just

respond. I just think that, you know, we have to look at the hierarchy of costs. We don't have unlimited resources to meet those goals. We have to default to some of these others. NRDC still. You know, we're not counting CCS, even though it looks increasingly like a longer and longer shot because the industries that would benefit from themselves don't want to do them.

So, you know, I don't think it's responsible to take anything off the table, but it's irresponsible I think to assume that everything has an equal ability to be implemented. And there should be an order in which we go about it that takes into account, and I think this is captured in our outline, too, the affordability of this.

CHAIRMAN COWART: Billy?

MR. BALL: I'm not going to weigh into the nuclear debate. Distribution. One thing, and I don't know that it really -- I'm just struggling here to think if it even belongs in this paper or not, David, so I'll just leave it with you to

think about it or for us to think about it.

You know, I was in a discussion a couple of weeks ago just about the distribution system we have now is pretty much -- there are parts of it, but not much. And all the tools and all the training that folks have in the distribution is still largely radial in its logic.

And it would seem to me that distribution is going to become just as networked as transmission is in the future, and how do you make that transition? It's not minor, but it's not impossible. But it sure involves re- training and re-tooling pretty much the majority of folks who deal in that space. And I don't know how we work that in here.

And I actually do think there are some pretty intriguing D.C. opportunities. I see Granger slipped out, but that was involved in the discussion a couple of weeks ago, especially in the context, I think, initially inside of a micro grid, you know. You can avoid transitioning back and forth and not create some costs beyond what

you would say if it seems it would make a lot of sense.

I don't know really know where that belongs in the paper or not, but I think the whole D.C. debate may actually get more and more important going forward.

MR. TILL: Thank you.

CHAIRMAN COWART: And, Sonny?

MR. POPOWSKY: Yes, thanks. Sonny Popowski. I was wondering, Doug Larson made a comment that I wanted you to comment on, that he thought that transmission might become the backup system. And I guess that means the primary system, I guess, becomes micro grids and local generation. Is that where you think we're headed, or maybe Mike Heyeck, since this is your last meeting, any thoughts about that as well?

MR. TILL: I've got some, and we'll let Mike answer. Let me give my disclaimer this is not for TVA. This is for David Till. Very many people it seems to me, some who have consciously thought about it and some who not have not

consciously thought about it believe that transmission will be a backup. I personally believe that transmission is an efficient and economic primary energy delivery system and an extremely expensive backup.

And I think if we go in a direction where people assume that it's going to be a backup, scales will fall from eyes as we move down that road. And we'll either have to rethink the decision, or we'll have to charge people a good bit of money for that backup system. Mike?

MR. HEYECK: Paul and I were discussing over the break the inertia of things. It's going to take a long time for the grid to change. I see a mixture of both, particularly in the coastal areas. You might get into the micro grids, but in Kentucky, in Wyoming, I don't see it there. I see wind farms, offshore wind driving the need for transmission as well as the fuel transformation that's going on in the central station goals. So by 2050, I see a room for both.

One thing that we're forgetting, we're

in a stagnant period of low growth, but I was mentioning to Paul that in Europe's 20/20/20 paradigm, they actually see an increase in demand because it's replacing other uses of energy. And in the United States in the big puzzle of things, there may be other uses of energy that may be more efficient with electricity than with its primary burning, whether it's industrial process or in transportation.

So bottom line for me, it's going to be a mixture of both, and we're trying to drive in this paper the rational middle that would assume the mixture of both.

CHAIRMAN COWART: Billy again?

MR. BALL: Yes, Sonny. I again was involved in some conversations last week on some of these topics with a different government agency and a lot of conversation around micro grids. I thought it was entertaining that we had a conversation in developing countries what a great opportunity micro grids will provide for some very rural areas with the hope that one day some of

these micro grids might actually interconnect to bring even greater efficiency. So I chuckled, right, too many people in this country seem to be trying to draw bright lines everywhere, and one is worthwhile, and one is of great value.

And really, I don't see these big, great bright lines, you know. I'm with Mike. I don't see this as a one or the other. I think this is going to be a great opportunity to have the power of the "and." And I don't view the transmission system or the distribution system as being just being just a backup. We're just going to see this whole integrated grid shift.

And you just have to go back to the beginning of the business. One of the speakers said today we just didn't have all the neat technology we have back then that we have today, so what a great opportunity because our company, most utilities, most transmission owners started, again, by small generators. Maybe they were making ice. Maybe they were providing energy source for a rail car, and they saw efficiencies

to integrate. Why would that go away?

It may change. The dynamics may change, but I don't really see any one piece ever becoming just a backup source.

MR. TILL: Further thoughts. I tend to see distributed generation micro grids as incompatible with transmission, not from the standpoint that they can't interconnect and that this area have micro grids and it tie into the overall system through transmission, but from the standpoint that the protection that's necessary for a distributed generation or a micro grid is so fundamentally, in my mind at least, incompatible with the automatic protection and controls for the transmission system that we'll have to plan interfaces as we go.

CHAIRMAN COWART: Chris?

MR. SHELTON: Yes. I think building on some of these concepts, I agree that I don't understand why the lines always have to be so bright. It doesn't make sense to me. And I'm thinking about these things, the whole system and

what the implications are for storage, and it's become more real to us as we've done more storage at AS.

But when you envision storage, if it becomes a significant alternative to a lot of our investment in combustioned turbines that are rarely used, get used about six percent of the time, the ones we've built over the last 12 years, you build a system that's much more elastic. And the total utilization of the transmission system, you know, and the key components of that system is not 100 percent. It's probably not 70 percent. So you've got an untapped resource in the latent unused capacity in the transmission system that's enabled by any significant penetration of storage into the generation fleet.

So if you took in the next 15 years 50,000 megawatts of CTs that EA forecasted and just make that storage, you have a very different system. It could flex 100,000 megawatts in one second if it was all inverter based. So that's a tenth of the system you would have in elasticity

in the system. It really changes how you think about the interfaces between distribution and transmission. It changes how you think about the load side or distributed resources and how they interface.

I think that's a very credible, possible future we have over the next 15 years. And storage just enables the grid to be even more central to everything, and that transmission will be, I think, more fully utilized and more central than it is today.

MR. TILL: Thanks, Chris.

CHAIRMAN COWART: Any other comments on the paper or the work plan?

(No response)

CHAIRMAN COWART: One thing I was just going to add, and this doesn't need to be in the paper, but I think it needs to inform sort of the positioning of the paper in my own opinion, speaking just for myself, I guess, that when we say the power of "and" here, I agree with that in terms of small needs big and the system needs

both.

But we also need to recognize simultaneously that demand response and energy efficiency at the customer locations are also part of the "and" that needs to be available in order to balance the system. And Chris just made the point about storage. The same is true of other kinds of demand response.

And the realization that what we're trying to invent is a system that can do numerous things using these new technologies to me is part of the message. So the transmission policy agenda has to take into account the distribution and customer-located agendas. And I suppose that's an obvious statement for this committee. I don't want to belabor the obvious.

And I think it's also the case than when we're talking about smart grids, so we're talking about storage and other aspects of the committee's work, we take account of the other buckets as well.

MR. SHELTON: And to add on the smart

grid and the demand response are other forms of elasticity, right? They fit in that same bucket, right?

CHAIRMAN COWART: That's right. And I apologize for even using the word "buckets" because I these are more like interlocking fingers than they are separate silos. Merwin and Carl.

MR. BROWN: Thank you. Merwin Brown, CIEE. At the risk of also maybe saying something that's obvious, and I hope at least this is helpful, I mentioned, I think, earlier that my team had taken on a question about what the future architecture would look like maybe 2050 for the electric grid. And we took a scenario approach.

And what we came up with was we picked two variables that we thought were the most uncertain and the most highly variable that would affect the future. One of them was technology development and adoption. We thought that went hand-in-hand. And the other one was the degree to which society will allow us to build our way out of this problem because there's two ways of

getting flexibility. One you can overbuild. Not overbuild. That's not a good way to put it. But you can build enough robustness that you can handle about anything. Or you use technology to bring in the flexibility that you need.

And as a result, we came up with four quite different scenarios, very different success factors in each one of them, varying degrees of transmission and distribution participation.

So I don't know whether that's any help in this particular outline, but if, one, I'll offer those comments to keep them in line as you're looking at this outline because it could change your outline considerably. And secondly, if you want what we've done, I'd be more than willing to share it with you, but it certainly isn't the last word. You could pick other variables perhaps, like what happens with electricity demand. That could be a factor whether it takes off again or not.

So for what it's worth category, that's how we came up with some very different answers

for the future, all the way from heavy emphasis on a micro grid approach to where transmission had a real hard time struggling, to the other side, which is more of the same of what we have, a lot more transmission, et cetera. So for what it's worth.

MR. TILL: Thanks, Merwin.

MR. ZICHELLA: Thank you, all. This is really fabulous feedback. One thing I would say in looking at this is we did try -- to Richard's comment -- to try to incorporate that sort of thinking. If you look at the outline elements, sort of the first things you tee up are if I could generalize it is understand what you need and build what you need, and then get the most out of what you've got, which sort of leads to taking advantage of the customer side of the equation as well as the transmission side of the equation.

As Mike said, finding the happy middle, I think we all felt transmission isn't going away. I don't know if I agree with Doug's comment that it'll be a backup. Certainly I think the

distribution system and the line between the two systems is blurring.

You know, if you look at how they can complement each other, if you can control them, you know, in an equivalent way, that's, I think, something we should try to capture as part of this that goes to the technology. We've spent a lot of time talking about the control architecture of the grid and how are we going to describe that and identify the needs to DoE that we might want to try to focus on to facilitate this very thing, the interface between the distribution grid and the bulk electricity grid.

I think that we can't look at them as being utterly separate anymore. At some point the controls around them, whether they're going to be operated more locally or if they're going to be integrated with a bulk operation, you know, they influence each other too much.

We're seeing DC improvements on the distribution systems of major utilities like LADWP looking at replacing some of their AC grid with DC

grid to get more transfer capacity because they can't find any rights-of-way. I mean, we're starting to see this stuff now.

And to Merwin's point about scenarios, I completely agree. I do think that it's very difficult forecasting the future. It's great fun prognosticating that. But we have to sort of look at what sort of things would we do anyway? And the greater efficiency things are the things you would do anyway, getting more out of the grid, designing a grid that can be expanded, re-conductored more easily. So the rights-of-way have value into the future, those sorts of things.

And I think we tried to reflect them anyway, maybe imperfectly in the outline, but they're there. And now as we start to write them, we have to make sure that concerns that we have today are well reflected in them. I do think nuclear wasn't mentioned at all pretty much in the documents, so we have to remedy that. It's part of the President's plan. It's got to be acknowledged in some way. The extent to which we

rely on it, I don't know, but we need to at least have it in there.

Anyway, I just wanted to thank everybody for their thought son this so far.

MR. TILL: I tried to get Carl to put nuclear in there.

MR. ZICHELLA: My arm still hurts.

CHAIRMAN COWART: We look forward to the fruits of your labors. Now, it's a total change of topic. I have a proposal here from my colleague. It's your idea.

MS. HOFFMAN: I just have a request. I don't know how many people are thinking about doing dinner, but I know the U.S. is playing the World Cup at 6:00. And so, there was a couple of us that decided maybe if folks want to go do dinner, that's fine. But I'd like to go to see the World Cup, so I know there's a couple of bars around here.

I think folks were looking into that to look at a place that maybe we could go socialize, watch a little bit of the World Cup. And then if

people want to have dinner, they're more than welcome to have dinner separately or stay and watch the World Cup to the extent that they want to stay. And so, that was the proposition that I put on the table.

CHAIRMAN COWART: Do we have any info?

MR. SUCCAR: This is Samir. So the good news is that the venue that we chose for dinner has a bar in the front that will be showing the World Cup. And so you can choose to be in the back or in the front depending on how much World Cup and soccer you want.

SPEAKER: Where is the place?

CHAIRMAN COWART: Across the street.

MR. SUCCAR: It's across the street.

CHAIRMAN COWART: All right. I'll tell you what. Before we get into the logistics, why don't we declare this meeting adjourned so the reporter can take a break? Yes. So we're now adjourned.

(Whereupon, the PROCEEDINGS were adjourned.)

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CERTIFICATE OF NOTARY PUBLIC

COMMONWEALTH OF VIRGINIA

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

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