BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

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IN THE MATTER OF: : Docket Number

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TECHNICAL CONFERENCE :

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Commission Meeting Room

Federal Energy Regulatory Commission

888 First Street, NE

Washington, DC

Wednesday, June 1, 2016

The technical conference in the above-entitled matter was convened at 9:38 a.m., pursuant to Commission notice and held before:

CHAIRMAN NORMAN BAY

COMMISSIONER CHERYL LaFLEUR

COMMISSIONER TONY CLARK

COMMISSIONER COLETTE HONORABLE

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PANEL I: 2016 State of Reliability

Panelists:

Gerry W. Cauley, North American Electric Reliability Corporation

Roy Thilly, North American Electric Reliability Corporation Board member

Patricia A. Hoffman, Assistant Secretary for the Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy

Commissioner David Clark, Public Service Commission of Utah, on behalf of NARUC

Miranda Keating Erickson, Vice President, Operations, Alberta Electricity System Operator

Paul Koonce, Chief Executive Officer, Dominion Generating Group, on behalf of the Edison Electric Institute

Marija Ilic, Professor, Carnegie Mellon University

Joseph Eto, Staff Scientist, Lawrence Berkeley National Laboratory

PANEL II: Emerging Issues - Part I: International Perspectives

Panelists:

Hector A. Beltran Mora, Director General, Unidad de Sistemas Electricos, Comision Reguladora De Energia

Klaus Dieter Borchardt, Director for the EU Internal Energy Market, Directorate-General for Energy, European Commission

PANEL II: Emerging Issues - Part II

Panelists:

Dr. Mohammad Shahidehpour, Professor Illinois Institute of Technology (IIT)

Chantal Hendrzak, Executive Director of Market Evolution, PJM Interconnection

Mark Lauby, North American Electric Reliability Corporation

Mark Rothleder, Vice President, Market Quality and Renewable Integration, California ISO

Lorraine H. Akiba, Commissioner, Hawaii Public Utilities Commission

Chris Murray, Project Support Lead, Renewable Energy Program Office, Department of Navy (FERC Detailee)

Allen Mosher, Vice President of Policy Analysis, American Public Power Association

Panel III: Grid Security

Panelists:

Devon Streit, Deputy Assistant Secretary for Infrastructure Security and Energy Restoration (ISER), Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy

Donna Dodson, Director, NCCoE and Chief Cybersecurity Advisor, National Institute of Standards and Technology (NIST)

Greg Ford, President and CEO, Georgia System Operations Corporation, on behalf of NRECA

Marcus Sachs, North American Electric Reliability Corporation

Professor Anna Scaglione, Arizona State University

Paul Stockton, Managing Director, Sonecon, LLC

Thomas Popik, Chairman, Foundation for Resilient Societies

Francis Bradley, Chief Operating Officer and Vice President, Policy Development, Canadian Electricity Association

Court Reporter: Sara A. Wick, RPR, CRR

P R O C E E D I N G S

CHAIRMAN BAY: Good morning, everybody.

One of FERC's statutory responsibilities under the Federal Power Act is to help maintain the reliability of the grid. Today's technical conference focuses on three key topics, first an assessment of the current state of reliability; second, emerging issues, both internationally and in the United States; and third, grid security. This is one of the most important technical conferences we hold each year, and I thank our panelists for coming here today, and I look forward to hearing their views on each of these topics.

I also appreciate the work of NERC and the regional entities in furthering reliability. It is a 24/7 responsibility. I also appreciate the hard work of Staff in putting together this all-day conference.

Staff has also reminded me that as a housekeeping matter I should mention the following three matters to everyone here today: First, no food in our conference meeting room, or coffee. No coffee either, only water. And please turn off your cell phones.

Colleagues? Cheryl?

COMMISSIONER LA FLEUR: Thank you very much, Norman, and thank you all for coming. We have quite a turnout, including folks from as far as Europe and Hawaii,

in either direction, as well as our continental colleagues from Canada and Mexico. And so we really appreciate the efforts everyone has made to be a part of this.

This is one of my favorite days of the year, and I think today's agenda is particularly meaty. I was fortunate to have a preview of the 2015 State of Reliability Report at the NERC board meeting last month, and I was very encouraged by the results, especially on relay misoperations, which is something Gerry has talked about at this conference at least for the last two years, possibly for the last three, and so it really shows really progress in that area.

In the agenda today, I'm particularly interested in learning from the discussion on what we've accomplished in 10 years and where we go from here. NERC was certified as the ERO in July 2006. So we are just on the 10-year anniversary, and I think that big progress has been made in transitioning the culture from the old voluntary organization which I was familiar with back in the day to the hybrid structure that exists now with the voting on standards, but with a strong enforcement and FERC regulation on top.

I think we have a strong framework of basic standards, and a lot of work has gone into defining the bulk electric system and streamlining the various

processes, especially the compliance processes, in the last two years.

I also think and hope we've made progress in building a strong relationship between the Commission and NERC and the rest of the ERO Enterprise. Because of the structure of the statute, the organization -- the work really relies on us having shared priorities to move the work forward, and I hope we are making progress on that.

In terms of going forward, I'm very interested in talking about where we go forward on resilience, not just on emerging issues like the new frontiers and cybersecurity and geomagnetic disturbances, but thinking about new ways to approach resilience. I saw standardization was on the topic. Equipment was on the agenda, equipment sharing, really thinking of how we build it in in the way that we design and operate the grid rather than just in the lagging standards after the fact.

I'm also very interested in how the ERO transitions to the steady state in streamlining the standards, making sure we have the right standards, you know, taking it forward now that we're not in the buildup period of how to go forward and make it better. And I'm interested in the topic on the agenda of whether we can have self-adjusting standards or some kind of structure that streamlines the process we have now.

So those and everything else, I look forward to a very interesting day. Thank you.

CHAIRMAN BAY: Thank you, Cheryl.

Colette?

COMMISSIONER HONORABLE: Thank you, Mr. Chairman.

Good morning, everyone. I'm delighted to join you today where we focus on a very important topic, and that is reliability.

When Congress passed Section 215 of the Federal Power Act it made very clear that a central role of our work here at the Commission is indeed ensuring reliability. And given that we've operated under mandatory reliability standards for roughly a decade now, I believe it's an excellent time to take stock of where we are, how our bulk power system is currently operating, and indeed the reliability challenges of the future and how we might tackle them.

I also believe that NERC's reliability assessments are always a useful tool, and I expect that the added perspective from the various panel discussions will help illuminate them.

So thank you, Gerry, and to your team at NERC. I also want to thank Pat Hoffman from DOE. Thank you, thank you, thank you. You always show up when we call, and

you are helpful, you and your staff, in many ways, and we appreciate the value that you bring to this discussion.

I'm also looking forward to the unique perspectives of our international colleagues and even our colleagues from the noncontiguous states.

I'm looking at Lorraine Akiba, the Commissioner from Hawaii. Thank you for being here. We look forward to your presentation.

I also wanted to mention in particular for our North American friends, Gerry Cauley and I were just together in Montreal at the CAMPUT meeting a couple of weeks ago where we discussed resilience in reliability. And as soon as we adjourn today, I will leave, going to San Antonio where I will join our Mexican colleagues to continue the discussion about energy tomorrow at a binational meeting on energy concerns for Mexico and the U.S.

So I said that to say we are eager to go where you are and we too welcome you here as well. In a time when the grid must accommodate the proliferation of various resources, increasingly sophisticated cyberattacks, and coordination issues caused by a rapidly shifting fuel mix, we must continue to be vigilant.

So with that, again, I want to end where I began in thanking all of our colleagues across the country who

work each and every day to ensure reliability, and extend a warm welcome to the regions of NERC.

And at the very back of the end of the room is a dear friend of mine, Napoleon Johnson with SERC. Delighted to have you here.

And I saw Greg Ford, who is the chair of SERC. We welcome you and look forward to the discussion.

Thank you.

CHAIRMAN BAY: Thank you, Colette.

Unless Staff has any comments they wish to make, let's go ahead and get started.

Gerry?

MR. CAULEY: Thank you.

Good morning, Chairman Bay, Commissioners, Staff, and fellow panelists. This is a -- I really appreciate this conference today.

I think the first one I was at was February 8, 2010, which is 6-1/2 years ago. It was a little bit rockier than they've become recently. But I think this has really evolved to be a very good discussion of reliability progress, priorities, and a lot of diverse inputs on reliability.

I view reliability risks in three broad categories. The State of Reliability Report addresses the first one, which is the traditional, conventional risks

that we can see and touch and measure and gather data on, really misoperation, situation awareness, equipment failures. There are -- and I'll talk a little bit more about that on this panel.

There are two other broad areas of risks we're facing. One is involved with emerging changes to the grid and resource mix, and we need the long-range view to forecast that and see where we'll be in years down the road. And also, of course, the severe impact risk such as physical and cyberattack, GMD, and so on. And these all must be treated in different ways.

I want to touch on the major accomplishments I believe we've made in the 10 years since NERC was certified as the ERO. We've matured the mandatory standards to very high quality today. We've expanded the standards to include severe risks such as cybersecurity, physical security, and GMD. We've created a risk-based compliance and enforcement program to ensure that we're focused on the highest-priority issues while reducing regulatory burden and process.

We've also established an event analysis, root cause analysis program, and we're pursuing a culture of aggressively fixing any issues we find out of that. We're getting 100 percent participation by industry, and I think we've got a record established of very aggressively fixing

issues that are identified, whether to the event program or through compliance.

We've participated in the stand-up of the Electricity Sector Coordinating Council. We've established what I call, I think is, the foremost information sharing and analysis center, and also we sponsor the GridEx exercise.

So how do we measure reliability? From the state of reliability perspective on the conventional risks we've seen a very good year in 2015 as the report tells us.

There were no category 4 or 5 events. There was one category 3 event in ERCOT, and the number of category 2 events were trending downward.

I believe as we see the smaller events become less frequent and smaller impact, it's a good sign that we're managing the risk of a bigger event. It doesn't say it can't happen. But we are having an effect.

We've reduced the number and severity of transmission outages and the impacts they have on load loss. In 2015, we saw a decrease in relay misoperations from 10.4 percent in 2014 to 9.4 percent in 2015, and the consequences of those outages have been reduced.

We've reduced the human errors resulting in transmission outages from one in every 21 circuits in 2013 to one in every 35 circuits in 2015. That's a very

significant measurable improvement on human performance.

We did well in 2015 on cold weather and winterization. There was a very cold period in February, and where we operated through and did not see the similar consequences we saw in 2014. And we've very successfully worked with industry to mitigate clearances on the right-of-way, both technical as well as vegetation management, and I believe that we're in a much safer condition for the public and ensuring reliability, public safety, and resilience by having adequate clearances.

These results show that we're having an effect. The question is now what should we do. We need to remain vigilant. So my priorities going forward remain -- equipment failures continued to have the highest correlation to significant outages. We're searching for the next area of focus on equipment failure that we need to address with industry.

Relay misoperations continues to have the second strongest correlation to actual outages we see. Human error continues to be the third. And we must continue to be vigilant in cold weather impacts on generators.

Frequency control is a concern of mine as well, although we are fairly stable at this point in frequency response capability in the interconnections. Day by day as we get new generators that don't have the effective

controls on frequency response, the issue becomes more challenging.

And of course, cyber and physical security. There were no cyber events in 2015 that had a load impact -- loss of load impact. There was one very small physical event on a 69-kV breaker that did result in 20 megawatts, but those are not really good indicators. The risks are severe. We must remain focused there.

My last point would be to underscore that the top 10 largest events in 2015 were related to weather. That was true in 2014. That was true in 2013. That was true in 2012. The last big event we had because of operational issues was September 2011. This really highlights for me the opportunity to continue to examine and dig deeper into the data around weather-based events to see if there's opportunities that become apparent to harden and ensure the resilience and recoverability of systems during natural causes.

So thank you very much. I look forward to your questions.

MR. THILLY: Thank you. I'm Roy Thilly, the vice chair, chair-elect of the NERC board. And I want to thank you in particular for the opportunity to provide a board perspective today. In addition, I want to thank the Staff of FERC and Commissioners for the support and

extensive involvement you have in NERC's work.

We share an important responsibility, and I think, have forged a much stronger collaborative relationship over the last five years, which is essential. Reliability also requires close coordination with many other partners beyond FERC and NERC, Canadian regulators, DOE, the states, and of course industry. And our board engages in extensive outreach to each of these partners. Excellent communication is essential when responsibility is shared.

The NERC board's role is to provide the oversight, guidance, and resources necessary to achieve NERC's mission. And we are charged with applying our best independent judgment in the public interest in everything we do, in approving plans, budgets, standards, compliance processes, enforcement decisions, assessments, setting goals, metrics, and evaluating performance.

In terms of achievements since I have been on the board, very substantial progress has been made by Gerry and the regional CEOs in forging a much more unified, efficient, single ERO Enterprise. That relationship has to be characterized by constant collaboration and driven to achieve consistency and application of standards, operating procedures, and enforcement outcomes.

Our board meets twice a year with the regional

board chairs and vice chairs to help move that effort forward and find greater efficiencies. At the board's urging and as a result of hard work by NERC Staff and industry, as Gerry mentioned, the standards process has improved significantly.

The result is a much more timely process. Better and clearer drafted standards, quality controls, and most importantly a strong focus on the real risks to reliability and desired outcomes, moving away from overly prescriptive requirements. The board has authority to develop and file a needed standard if the process fails by delay or deadlock. And in several instances, we've made clear our intention to use that power. That message has proven sufficient.

In compliance and enforcement with FERC's help, we've moved away from a zero compliance regime, what I think was very damaging in many respects, to a risk-based approach that focuses on entity risk, internal controls culture, self-reporting, and resolving minor infractions expeditiously. That result has eliminated a very substantial backlog and most importantly allowed us to refocus our attention, industry to refocus, and FERC, on where the real risks to reliability are.

The trade-off for compliance exceptions is greater attention to serious violations. The board

committee on compliance focuses not only on monetary penalties, speed of mitigation culture, and consistency, but also on incenting organizational changes and, most importantly, investments, the equipment in software that is beyond mitigation requirements and above the norm, so that we enhance reliability performance.

Finally, I would like to state that NERC's assessments have become much more focused on existing emerging risks that will be discussed at length today. From the board's perspective, the objective is a highly credible work product that is valuable to all our partners with reliability responsibilities and to the public. And the key there is resource and policy neutrality and the exercise of NERC's independent professional judgment after listening to various inputs but not seeking consensus, speaking to what we really see as the issues before us.

The final thing I'd like to say is that I think on security, the relationship developed with the ESCC at the CEO level to provide strategic guidance and support enhanced by ISAC, CRISP and GridEx exercises is very important, and I'm really pleased to see the substantial increase in ISAC participation by the industry and the growth of CRISP.

CHAIRMAN BAY: Thank you.

Assistant Secretary Hoffman?

MS. HOFFMAN: Thank you. And I thank you for the opportunity to express the views of the Department of Energy on a range of important issues related to reliability, both today and tomorrow.

As Gerry has stated, reliability has become more important than ever before. We're in the early stage of a grand transformation of our electricity supply system, and this process of change is likely to continue for many years. What I'd like to emphasize is while we're in the middle of this change, we need to keep due diligence as we look at coordination and unprecedented coordination as was mentioned earlier by the Commissions and collaboration among numerous parties to ensure while we're in this transition we have stable reliability.

I would also like to compliment NERC in their state of reliability assessment and their activities. I think NERC has taken a leadership role and has been very forthcoming in looking for innovations in metrics and activities under their leadership.

But I also want to emphasize that this may not be enough, that we need to recognize there is an entire system that we have to think about with respect to reliability, not just the bulk power facilities in the market, but we now need to start thinking about the distribution systems, the components that are being added

to the distribution system, especially some of the things on the customer side of the meter, as we take a holistic view of the system.

We know that at the bulk power level, we have had many expertise and many support. We've had decades of experience in the design and operations of these systems and the development of reliability standards. But by comparison, in the distribution system, we are at the early stage of creating a cadre of professional planners, distribution-level reliability standards, metrics, and mechanisms for visibility and observability.

The Department of Energy is working with the national lab grid consortium to look at a couple of projects with the states, really to help the states think through the process of how do they want to involve the distribution system.

Other important emerging issues continue with -- are continuing with the growth and interdependency of our generation supply in the natural gas supply system. I want to congratulate the Commission for its past and ongoing activities to explore concerns related to the gas/electric interdependency, but I also want to encourage the Commission to keep the pressure on.

Aliso Canyon reminds us of the attention it needs that is also required on this topic. The Department

of Energy has a task force looking at gas storage safety. We are working with Argonne National Laboratory to review the safety conditions of 400 natural gas storage sites and gauge the significance of these facilities in the regional or local electricity system.

But I also emphasize the importance that the Commissions should continue to look at fuel diversity, as well as dual fuel capabilities, to address some of the issues that Gerry had mentioned in the winter, critical winter season.

With respect to successes and needs, I want to provide the following insights. I believe we are at a crossroads, and my concern is that maybe not all the paths will lead to the same outcome. We do have a symbiotic relationship between markets and reliability, but we have a new dimension that we must consider when the act of management of the grid becomes more distributed.

The role that I would ask for the Commission is to work with the states to watch out and identify for potential interstate effects. Sometimes we at the Department of Energy commonly call these seams issues, and I would ask the Commission to think about that.

Initiatives have been great and valuable for the deployment of transmission, but I think we're all recognizing now that the grid is a battery for the system.

It is basically the backup for the system, and it's more and more being relied on as such.

And so what are other incentives that we might think, of investment opportunities to support reliability. On the research side of things, the Department of Energy has been really trying to develop some tools and capabilities that will help advance the reliability of the system. There have been many improvements in the technology and capabilities over the past year, some successes. The synchrophasor technology is an example of success in monitoring disturbances, along with improved generator models, and hopefully will ultimately be a platform for visualization across the system.

Though as the power system complexity continues to grow, so will the need for more advanced analytical platforms. The next-generation grid will also require novel system designs and analysis, which will in turn depend on application of breakthroughs in mathematical sciences.

I brought today the National Academy study on next-generation mathematics and modeling for the grid that I would love to leave for the Commission Staff to review. It has some very good recommendations for machine learning, data, and opportunities for mathematics on the system.

But at the end of the day, we're going to have

to go to more dynamic breadths, means, and dynamic opportunities.

So with respect to security, just in closing, I appreciate all the work that the Commission and NERC has done in the security area. I am concerned that security events will be malicious in nature and will not be addressed by a simple N minus 1 criteria. And so we are going to have to continue to work together to not only look at security but think about state energy assurance as well as critical infrastructure mission assurance, and unfortunately these investments are not valued by the market.

So with that, thank you.

CHAIRMAN BAY: Thank you, Assistant Secretary Hoffman.

Commissioner Clark?

UTAH COMMISSIONER CLARK: Thank you very much, Chairman Bay, Commissioner LaFleur, and Commissioner Honorable. It's a great privilege to be here today, and it's a personal pleasure to see each of you again.

I'm representing the National Association of Regulatory Utility Commissioners, as you know, and I serve as a commissioner in the state of Utah, the Public Service Commission there. I'm one of two government sector representatives elected to the Member Representatives

Committee of NERC, and today, I want to just touch two topics briefly.

But before I do so, I also want to applaud the diligent and effective efforts of NERC and the eight regional entities. The ERO Enterprise has very difficult and highly technical set of responsibilities to assure the reliability of the bulk power system, and in my judgment, they're carrying out those responsibilities with admirable effectiveness.

We particularly value the strong relationships that we have developed with NERC as state regulators. We appreciate their willingness, particularly Gerry's willingness and his leadership team's willingness, to engage with us in various state and regional and national conferences. We think this is a vitally important relationship, and we highly value NERC's willingness to undertake special assessments related to emerging issues, and I would just focus as one example on the special assessment related to the clean power plant, a multiphase, multiyear project for NERC.

Now, my two topics briefly are, first, the cost of compliance with standards. As an economic regulator, I know you would expect me to address this, and it is important that we consider costs in the standards development process. We believe that appropriate

cost-benefit analysis is a critical component of the culture of reliability excellence.

I would point to the reliability assurance initiative that Mr. Thilly mentioned as an important transition from a zero tolerance perspective to a more risk-based approach to compliance monitoring and enforcement.

I am also very interested in NERC's cost-effectiveness method pilot that it's made a part of its work plan for 2016. We hope, personally I hope, that that pilot will lead us to some important discoveries regarding how costs can better be contemplated and assessed in the standards development process. And we very much appreciate NERC's responsiveness to NARUC's interest in cost-effectiveness and its commitment of resources so that we can better understand the costs utilities bear to comply with reliability standards in relation to the intended benefits of those standards.

Now, my other topic is the changing resource mix that I know is going to be discussed in greater detail by the panels that follow. And so I'll simply say that on -- as state regulators we also have an awareness of the implications and of the importance of continuing to focus on that changing resource mix. It is of vital importance for us to understand how the new resource mix will impact

reliability, both at a generation transmission and also a distribution level.

And as a Westerner, I'm particularly interested in and concerned about the shutdown of the Aliso Canyon storage facility and what that points out to us about the interdependencies of the natural gas infrastructure and the electric generation infrastructure. And I'm again hopeful that this meeting today and NERC's very important report on this subject of interdependency will help us to develop a more proactive and longer-term strategy for addressing the interconnectedness of these two infrastructures.

Thank you very much for allowing me to be with you today.

CHAIRMAN BAY: Thank you, Commissioner Clark.

Ms. Keating Erickson?

MS. KEATING ERICKSON: Thank you very much. Good morning. And thank you for the opportunity to be here today. My name is Miranda Keating Erickson. I am the president of operations at the Alberta Electric System Operator, which is the Independent System Operator for the province of Alberta in Canada.

Really, there are three things that I would like to address today. The first, as we contemplate the standards process, I believe it's critical to our successes in industry that we recognize one size does not fit all.

And as with any process, over the past decade as we moved from voluntarily to mandatory standards, we've seen a pendulum, swing from undocumented processes and voluntary standards with little to no enforceability, through to extremely detailed, regimented mandatory standards with an enormous amount of documented processes and administration. This was likely necessary, allowing us to achieve a consistency of practices and system performance across jurisdictions, documentation of practices that were previously passed along verbally or only documented informally, limited degradation of system reliability over time due to regularly scheduled reviews and audits of limits, settings, and operational performance, and proactive identification of operational risks.

But as with any process, there comes a time when the pendulum needs to settle out, and the process can and should be right-sized. There are two competing challenges here. One is a desire to minimize change. Steady states for standards is really desirable to minimize unnecessary work on minor revisions.

But the other is ensuring our focus is truly on operational reliability, reducing unnecessary administration and paperwork that don't actually contribute to reliability. I believe that NERC is on the right path

forward as they look to take a more risk-based approach in the standards process.

As a sidebar, we have a somewhat unique process for adopting mandatory reliability standards in Alberta which has enabled us in some ways to begin to tackle this concept of right-sizing. We're required to review each new or revised NERC standard, determine its applicability in Alberta, and where appropriate, to amend the standard to make it technically relevant in Alberta prior to putting it in front of our utilities commission for approval.

For example, we have no nuclear facilities in Alberta, and so we haven't adopted any of the standards that apply to the operation of nuclear facilities. Because this process takes some time, by design, we're able to learn from other jurisdictions as the standards take effect and apply a critical eye to each requirement. This allows us to maintain consistency with other jurisdictions, but in some ways advance a step in terms of focus and priority on which requirements will really benefit the reliability of our system versus those more administrative in nature.

Second, and I won't spend much time on this as I recognize there's a panel addressing it in its entirety today, the power system that we all know is changing. The paradigm shift in system planning and operations resulting from the increase in renewables and distributed energy

resources, along with the increasing reliance on natural gas as a supply source, will continue to be a challenge for the industry as a whole.

The change in system characteristics may mean a need for different or additional ancillary services and performance criteria to ensure the reliability of the system. We now need to consider the impacts of fuel supply disruptions on reliability.

The increasing volume of distribution-connected variable resources must be taken into account in system planning and operations, and at the same time, we need to deal with aging infrastructure and a much more challenging regulatory environment to get additional or new infrastructure built.

Third, and this point has certainly been driven home in Alberta recently, we must remember that no amount of standards can prevent all events from happening. Snowstorms will happen. Ice storms will happen. Tornadoes and hurricanes will happen. As I well know, floods and wildfires will happen.

Let's not kid ourselves. At some point cyber and physical attacks will also happen. That means resiliency is just as important as prevention. It is critical that we focus on our ability to minimize impacts and improve response and recovery time when these events do

and will occur.

Thank you very much. I look forward to our discussion today.

CHAIRMAN BAY: Thank you.

Mr. Koonce?

MR. KOONCE: Yes. Mr. Chairman, Commissioners, FERC Staff, thank you for hosting us this morning. I'm Paul Koonce with Dominion Resources. I appear from Richmond, Virginia. I won't get any accolades for the long distance of that travel to be here, but I'm happy to be here just the same.

Five quick comments. Commissioner LaFleur, EEI -- I'm here on behalf of EEI. We certainly agree with you that NERC is improving reliability. Under Gerry's leadership the standard-setting process has been streamlined and is working. CIP Version 5 is sound. We believe that it will protect the system from physical and cyberattacks today, and we think its design will work in the future. So we don't think that new standards or modifications are needed. The reliability assessment program is focused on reliability, as it should be.

Secondly, we think that NERC's proposed GMD standards should be approved as it is. It's an excellent first step. It may not be the final step, but it needs to be adopted.

Third, I would observe that NERC, FERC, and the industry need to continue to work on day-to-day dialogue. As much progress as we've made over the last 10 years, I think the supply chain NOPR and the information-sharing NOPR may provide insight into recent examples where we need to improve communications.

On renewables integration, EEI does not believe that one size fits all. We continue to advocate that FERC should schedule separate technical conferences for each interconnection. Resource mix, planning criteria, and market rules require that these integration issues be addressed separately.

And lastly, I'd just like to applaud NERC on their reliability assessment program. As Gerry mentioned, focusing on weather events is a good next step. But it's so important for NERC's credibility to maintain technical accuracy. I think it's been a real benefit to our industry, and we want to continue to support it and see that happen.

Thank you.

CHAIRMAN BAY: Thank you, Mr. Koonce.

Dr. Ilic?

MS. ILIC: Good morning. I am -- I teach at Carnegie Mellon University, and I don't represent anybody. So it's just my own views based on long-term research -- so

as everybody else pointed out, I think NERC and FERC have made big progress in defining mandatory standards. However, there exists several -- these elusive issues which must be addressed to streamline future standardization, and some of them were pointed out by previous speakers.

First issue, it's a little bit longer-term and general view. So please bear with me. It is fundamentally impossible and inefficient to map any system operating problem into uniform technical specifications for all system equipment so that the problem disappears. So if you have loss of synchronism, you cannot tell what every piece of equipment should do. So that is normal. This was a nonissue in the bandwidth regulated industry, but now it is a true issue, because we have to map something that you take a full responsibility for into different responsibility by different BPS members.

Second issue, which is a high-level issue also, that standards greatly depend on the way the system is operated. This calls for rethinking operations so that BPS members clearly understand their responsibilities and act accordingly.

So to overcome these issues, system operators must collect common information about the ability and willingness of all BPS members to participate in an existing service and to minimally coordinate with them

online in operations, and that applies to generation, demand, TSOs, DSOs, microregions -- owned -- et cetera.

This looks like a hard thing, but our R&D indicates that such common variables can be introduced and that they are physically intuitive and economically meaningful variables. They are natural extension of today's economic dispatch and ACD paradigms, but they have to be extended over all BPS members, over all dynamic ranges, and for all conditions.

So it's fairly straightforward -- so those are the common variables that all BPS members have to provide and common metrics which are based on these variables become ranges of power and rate of change of power to be produced or needed and ranges of acceptable voltage and for frequency mitigation by all BPS members and -- quality of service. So two things.

So no more is needed, it appears, according to our research. So we observe also that the stated fact, then, one size does not have to fit all. The same common variables are used to communicate abilities, but not the same ranges are required on everybody.

So there are also a couple of very interesting implications if one takes these, but goes this way. Internal information about BPS members including models and parameters does not have to be revealed. This is a huge

issue with manufacturers. As we put new equipment on the system, utilities want to know what's inside. It's not going to happen.

So to make reliable operation more efficient, cost curves -- need to be provided. So if you say I operate in that range at that rate and this is the cost of that operation of that need.

So to get there, I think there are a couple of fairly serious technological challenges. BPS members need lots of automation to operate these common metrics. If they say they will do that, they need to carry out technology -- that they do it.

And also system planners and operators who are ultimately responsible for reliable service must enhance their computer applications to manage these highly distributed BPS members online as system conditions vary. It is their responsibility to report to regulators what needs to be enhanced, where and why, and to make recommendations in terms of the same common system-level variables and metrics that everybody understands. So it becomes simple, but it has to be done.

We call this -- a lot of references I put in my testimony before that refer to these dynamic monitoring -- DyMon, as which is basically just next-generation start-up. Like extension of that. And many are currently considered

complicated standards, but -- and we had questions on the primary, secondary -- reserve, reactive power support, all become -- operating in power plants. But actually you have a common way of expressing them.

So in closing, the challenge of setting and justifying the reliability standards in the changing industry is overwhelming. This should not be underestimated. It is a tremendous opportunity for -- innovation, its value, if you take it seriously, and NERC and Commission should take the lead in plowing this way forward. Economics could also help.

Thank you.

CHAIRMAN BAY: Thank you, Dr. Ilic.

Mr. Eto?

MR. ETO: Chairman Bay, Commissioners, Staff, and fellow panelists, thank you for the opportunity to share information on electricity reliability research that I've conducted that's relevant to the focus of this panel on the 2016 state of reliability. My comments will focus on the third topic listed for this panel, metrics. The research I will draw upon was funded by the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability, and hence, my comments will build from and add details to those that have already been provided this panel by Assistant Secretary Hoffman.

That said, I wish to clarify the opinions and perspectives I express are my own and do not necessarily reflect those of the Department of Energy or of the Lawrence Berkeley National Laboratory.

Let me start with the importance of reliability metrics and the need for improvements to them. The often-used management dictum that one can't manage what one can't measure provides the organizing rationale for the use of reliability metrics. To the starting point, we must further qualify the rationale by distinguishing between and separately taking account of the aspects of reliability that one can, in fact, manage, such as storm hardening, from the aspects that one cannot manage, such as the frequency and intensity of storms.

And finally, along these lines, it is essential that we acknowledge a quote attributed to Albert Einstein. Not everything that counts can be counted, and not everything that can be counted counts.

The reliability of the electric power system has long been the focus of analysis. Many -- metrics are in widespread use. They have been developed to assess specific aspects of reliability considered from a variety of perspectives. The purposes they serve by and large remain important today, and so reliance on them is expected to continue for some time.

Still, there are opportunities for improvements and expansions upon existing metrics. These opportunities have been created by the new uses for and the increased importance of information on the reliability of the power system.

Now, I divide existing metrics for reliability into two types, lagging and leading metrics. Lagging metrics measure what has happened such as how long or how often electric service has been interrupted. They include the System Average Interruption Duration Index, know as SAIDI, and the System Average Interruption Frequency Index, known as SAIFI, both of which are widely used by distribution utilities. They also include reporting on large individual events such as those that are reported to the North American Electric Reliability Corporation, or NERC, following the Standard EOP-004, and to the Department of Energy using Form OE-417. These metrics are thought to be relevant for managing transmission system operations.

Finally, lagging metrics also include metrics specifically linked to the restoration of electric service following power interruptions such as restoration time. These are used by both transmission and distribution utilities.

Leading metrics measure aspects of the state of the power system prior to the occurrence of the events that

cause power interruptions. They are used to help assess how well the power systems were prepared for these events. For the transmission system, NERC further divides these metrics into metrics associated with resource adequacy such as reserve margin, both on a planning and operating business, and operational security such as N minus 1 planning.

With respect to lagging metrics, there are two major areas where improvements are needed. First, there is a need to expand traditional metrics on interruptions to allow for explicit consideration of the economic impacts of interruptions on customers. SAIDI and SAIFI, for example, are system-wide averages that do not by themselves tell us anything about the actual experiences of customers during interruptions such as how long a customer is without power or how frequently. More importantly, they do not by themselves distinguish among customers. Yet, we know prima facie that the economic impacts of power interruptions can vary by orders of magnitude, depending on the type of customer affected and how long or how widespread an interruption is.

Second, we need to better align the measurement of reliability or, rather, the sources or causes of reliability events, that is unreliability, with the institutional structures we rely on to manage and oversee

reliability. Specifically, lagging metrics must evolve to distinguish between -- and enable more precise state-led regulation of distribution reliability separate from federal regulation of transmission reliability.

With respect to leading metrics for reliability, the principal area for improvement lies with taking more explicit account of uncertainty and prospective assessments and with the formal recognition and incorporation of risk management techniques to address these uncertainties in decisionmaking.

I'm going to close with some early successes in a path forward toward some improvements in these metrics. Fortunately, thanks in part to support provided by the Department of Energy, especially the Office of Electricity Delivery and Energy Reliability, progress is being made on all fronts. With respect to more granular information on customer's individual experiences with power interruptions, the Department of Energy's Grid Modernization Lab Consortium has initiated a major research project to develop enhanced reliability metrics, along with other grid metrics, that will seek to capture this information in future complements to additional SAIDI and SAIFI.

In addition, as a part of the Smart Grid Investment Grant program, the Department of Energy has developed the Interruption Cost Estimate, or ICE,

calculator that allows utilities to factor in the cost of interruptions by customer class, duration, and timing, into economic assessment of reliability enhancing improvements, such as undergrounding distribution lines.

The tool is based on the collective results of 37 value lost load surveys conducted by utilities over the past 20 years. The tool is publicly available online via Web site hosted by my laboratory, and its use is free of charge. We know that the tool is already being used to support regulatory filings for distribution system investments in several state jurisdictions. Moreover, the Department of Energy is sponsoring additional research to make the tool more useful in estimating the economic cost to customers associated with long duration and widespread interruptions of power.

With respect to improving the availability of SAIDI and SAIFI and better aligning the information they provided with state versus federal oversight of reliability, the Department of Energy has worked with the Energy Information Administration to collect and publish SAIDI and SAIFI metrics for all utilities.

Importantly, the EEI data collection requires utilities to report these metrics separately for the loss of supply, which provides a first-order proxy for distinguishing between interruptions originating from

within the distribution system and interruptions originating from outside or upstream of distribution systems in the subtransmission or transmission system.

More work will be required to fully align these classifications with FERC's oversight of the bulk electric system. Still, this is a very promising start. And in this regard, we are excited to have begun collaborative work with NERC to enhance existing reliability metrics, concentrating first on the potentially changing interface between the distribution and bulk electric systems.

Finally, with respect to the treatment of uncertain prospective assessments and imagined approaches for reliability, the Department of Energy is supporting academic and national laboratory research on advanced techniques to incorporate these concepts into power system planning.

There is no shortage of promising approaches. The challenge is to engage stakeholders by demonstrating these techniques side by side against current deterministic approaches and thereby begin charting the path toward more formal adoption by incorporating the insights they provide into current decisionmaking processes.

This concludes my prepared remarks.

CHAIRMAN BAY: Thank you, Mr. Eto.

First, let me thank again NERC and the regional

entities for their good work.

I do think it's significant, Gerry, that the last major system disturbance occurred in September 2011. That's right. Let's keep our fingers crossed, and at least non-weather-related disturbance.

So my first question is, what risks keep you up at night? And anyone on the panel is welcome to tackle that one as well. But I'm curious to hear what you regard as the issues that concern you the most going forward.

MR. CAULEY: Thank you for that question, Chairman. I do sleep well, but I do worry about things.

And I think the thing I worry about most is anything that destroys or damages equipment that would make it very difficult to recover. So I look foremost at a physical attack, although very unlikely. I think we do a great job with intelligence and law enforcement to ensure we don't have the eight or 10 vans going out to different sites and blowing things up. But I worry about that because of the potential long-term impacts and the difficulty of recovering, possibly lasting into weeks or months. It's something we want to make sure that we prevent. It's much more difficult to do that through a cyberattack. So that would be my number one issue that I worry about.

CHAIRMAN BAY: Anyone else on the panel?

MS. HOFFMAN: If I could just add, a couple things keep me up and night, and not that we can do anything about it, is some of the outlier weather events, the extreme weather issues. When we look at Aliso Canyon in California, it's the monsoons or it's the day of no sun shining, and some of that.

The other thing is, going back to some of the interdependency points, thinking outside the box, I think the Commission has done a great job in looking at some of the fuel interdependencies, the discussion on the supply chain or the manufacturer supporting the electric industry. But there is another interdependency with respect to like the telecom. So things along that, thinking a little bit outside the box of some of those interdependencies.

CHAIRMAN BAY: Commissioner Clark?

UTAH COMMISSIONER CLARK: Thank you, Chairman Bay. Both of the preceding comments relate to my thought, and it is the potential vulnerabilities that we have with natural gas infrastructure, with gas processing plants, with interstate pipelines. And while an attack might be remote, it's a very challenging prospect, to conceive how those assets can be physically protected. And so that's something that I spent some evening hours pondering.

Thank you.

CHAIRMAN BAY: Dr. Ilic?

MS. ILIC: So I think that one of the sort of hidden problems may be overall complexity of operating the system, because now we have bulk power system operators, TSOs, DSOs, nonutility things embedded and everybody's doing something online. So this is why in my comments I emphasized that there has to be some more information exchange, and who is responsible for what, and minimally coordinate that.

If you look into the blackout of 2003, I served for FirstEnergy, there are three documents there on how this could have happened to any other utility. It doesn't matter that the triggering event was there in FirstEnergy area, but no utility was ready for not having the information from the state estimator and for sort of hidden set of cascading events that could have been prevented with more automation and more technology if that complexity had been handled in a more systematic way. It is my firm belief, maybe biased, that we're going to have more and more events of that kind, you know, when the system operator just waves his hands and doesn't know what's next.

Thank you.

CHAIRMAN BAY: Mr. Thilly?

MR. THILLY: On a more mundane level, there's no question that not only preventing but containing, avoiding the cascaded restoring power in a security threat or severe

weather is a crucial item going forward.

I also have concerns, though, about the adequacy of the bulk electric system through a period of rapid change and retirements. Authority with respect to adequacy is split between market mechanisms, between some states that have authority and others don't. And NERC's role is in assessments, in shining a light. But it is others that have to take the action necessary to ensure adequacy.

And the other concern I have is in getting the infrastructure built in a timely way necessary to support the changes that are occurring in generation, particularly for wind, at a distance, for natural gas. And those are -- we need to get the infrastructure built so that the system remains reliable and do it in a timely fashion.

CHAIRMAN BAY: Mr. Koonce?

MR. KOONCE: Yes, Mr. Chairman. I think, you know, the industry has made great progress with the ES-ISAC, the information sharing that's happening among the industry in terms of component testing and all. I think the Electricity Subsector Coordinating Council is doing great work, working with DOE and our federal agencies and making sure that we have the information, that we're responding to all the threats that we're aware of and how we do that.

I think the one thing that probably keeps me up

at night is really the modeling, and that is the -- sort of the N minus 1 criteria that we've relied on. And I know my company, and we've worked with NERC and we've worked with Joe McLelland, and we've worked with Pat Hoffman, and we've done a lot of work to look at multiple component failure to sort of assess, is there something sort of hidden in the operation of the system that would not reveal itself in just a classic N minus 1 analysis.

And so I think, you know, one of the things that keeps me up at night is, you know, are the transmission operators around my system, are they looking at their system through a similar lens to make sure that something doesn't begin on their system and cascades into me.

So I really think as an industry, and I applaud Gerry's work in this and the Department of Energy's work, I think really coming up with sophisticated models that can look at multiple event failures, to really stress test the system to make sure we know how it's going to operate if you were to have some sort of physical attack on multiple components at one time, how does it happen?

MS. ILIC: May I just add one thing to this?

CHAIRMAN BAY: Sure, Dr. Ilic.

MS. ILIC: I think we have to really clearly differentiate between analysis tools versus saying okay, why were -- when the first event happened or bunch of

events happened, I had these mitigation tools. Then the next event would maybe not happen. So the cascading events is a function of how we operate the system and how we island, how do we, you know, prevent it from spreading, wide spreading. I think that that's -- even thinking about academic research, which I'm familiar with, we are weak on that side. We actually need to do much more of mitigation tools rather than analyses, and modeling is the first step.

Thank you.

CHAIRMAN BAY: Yes?

MS. KEATING ERICKSON: Just very quickly, I'd like to echo one of the comments that was made about adequacy and tie it to the concept of resiliency. So as we look at all the other things that keep us up at night, the ability to recover from whether it be an extreme weather event or a physical attack of some kind, in -- along with the difficulty of -- as we deal with aging infrastructure and the need for adding infrastructure and ensuring adequacy in the future, you know, as we run systems that are tighter and tighter, the ability to recover and to mitigate the impact of those kinds of events gets more and more challenging. So I would pull all of those together and say that's what keeps me up at night.

CHAIRMAN BAY: Thank you.

Some of you made comments that lead to my next

question. So we've talked about some of the greatest risks that you worry about.

What are the greatest opportunities to enhance reliability, whether it's through innovation, better modeling, or something else? I would be very interested to hear your views on that particular issue and whether there's a role for FERC in trying to incent that particular development.

MR. CAULEY: I have a quick list, Chairman, so I'll go through the list. I think -- in terms of essential reliability services, as the resource mix changes, I really think that storage is going to have a future and the ability to have electronics around could effect the controls of new resources. I think synchrophasor technology will become extremely important in the future in terms of our ability to see and control the grid.

I'm particularly concerned and I think there needs to be a lot of work done on distributed resources and how they are effectively integrated into the grid so we get seamless control effect between distribution and bulk power.

In the security world, we're looking at making a paradigm shift toward computer-to-computer monitoring of cyberthreats and self-healing and coordination electronically.

And I think all of those first few lead to the opportunity, I think, in gathering big pools of data. You know, there's a lot of talk about big data, but I think truly analytics are going to make that shift at some point to understand patterns that are very subtle, you know, sort of learning from experience and seeing sort of patterns in data that humans can't really come to.

And the last technology shift, I would think, is around resilience, in terms of being able to harden and make the system more recoverable, modular equipment that's more standardized. I think even -- how do you recover the logistics around cyber -- a major cyber event recovery where a lot of equipment is destroyed. It's both a logistical problem, but I think it's a technical problem. So I think there's a number of great research and technical development opportunities. There's probably more, but those are at the top of my list.

CHAIRMAN BAY: Thank you, Gerry.

Anyone else?

Yes, Mr. Eto.

MR. ETO: Our research suggests that reliability is getting worse over time, principally due to the occurrence of what are called major events typically related to weather. Our research also indicates that the majority of time folks are without power due to problems

that originate from within the distribution system, over 94 percent of the time.

So without taking anything away from the salience of the big events that effect many people at once, the little events that are affecting people the greatest on an average basis over the course. And so this issue about major events suggests that a focus on resilience and recovery and distribution planning is a very important and potentially a very low-hanging fruit to go after in terms of does it -- advanced technology clearly plays a role, but a lot of it's just about building the poles to be a little strong or having the cross wands that can break away rather than take down the entire pole. So I think there's a lot of unexplored potential there.

CHAIRMAN BAY: Thank you, Mr. Eto.

Yes, Dr. Ilic?

MS. ILIC: Just returning to some comments that I made earlier in my discussion, I think bringing some order of information exchange, information protocols between different entities, between distribution system and TSO operator, TSO and regional operator. The problem of seams that was mentioned earlier is really the problem of not having binding information exchange and binding following the rules in between. TSO doesn't do what TSO expects us to do and once the information is not there,

then everything begins to fall apart.

So I think very serious research, we've been doing that at CMU, but there are not very many people doing it actually on what information you need to exchange, for what purpose, and how is that all related to the standard that needs to be met.

And so I have sort of 15 pages of testimony. So if people are interested, there are a lot of references there. But it just has become an unmanageable problem without revisiting SCADA. Because SCADA is all top-down, you know, and now we need multidirectional, multilayered information exchange at multiple time scales.

So that is a huge challenge, and it could actually be big opportunity for computer industry to deploy its software and all that. You know, it could help operating the physical system. But we don't have -- we don't quite have the fundamentals that we agree on, why things should be exchanged and how is that related to failing operation.

Thank you.

CHAIRMAN BAY: Thank you.

Yes. Assistant Secretary Hoffman.

MS. HOFFMAN: I guess the only thing that I would add to this conversation is the ability to look for appropriate sensors on the system, talk about visibility of

equipment damage, looking at failing transformers and transformers, maybe that would help some of the insights that NERC is looking for. I think the visibility observability is an important issue across whether it's the distribution system, if we can have some standard platforms that everybody can share the information and do analytics on an equal platform. People do different contingency models, different types of modeling, but we can't seem to -- when we try to resolve those models, we have difficulty.

And then the ecosystem of resilience is very important, having recovery strategies, looking at supply chains, but investing in a stronger system based on lessons learned.

CHAIRMAN BAY: Thank you.

Mr. Koonce?

MR. KOONCE: Yes, Chairman Bay. My EEI colleagues would be upset if I didn't put a plug in for economic regulation. This is difficult and expensive stuff that we're doing, and maintaining returns that continue to track capital is key. It's not new, but it's always important.

Thank you.

CHAIRMAN BAY: Thank you very much.

Cheryl?

COMMISSIONER LA FLEUR: Thank you very much.

I think all of your comments were excellent, as well as your prefiled testimony or prefiled comments.

Gerry, I appreciate your comment about aggressively learning from issues that happen. I think that's been a hallmark of your leadership and has led to a lot of the progress we've made. And I think today is an example of trying to learn from what's out there.

So in that spirit, I have a couple of things I want to delve into. One thing that you said, Gerry, that was music to my ears was something along the lines of we've had fewer big issues since the September 2011 because of paying attention to littler issues. And I am -- I've said before, but I'll say again, there's a lot of research, a lot in the safety area, but across all processes, across aviation, healthcare, as well as industrial safety, showing a relationship -- a repeatable statistical relationship across industries and decades between little things going wrong and preventing the thing at the top of the pyramid, the big thing going wrong.

And I believe that's kind of the basis of the standards, that if we can define the leading indicator standards right, whether it's setting a password or trimming a tree a certain way, then that'll collectively prevent the top -- at least that's the concept.

And so I wonder if there's any research that the academics at the table or others know of, kind of the effect, like how -- what the relationship is. I know there's a lot of research, I think, on tree trimming, of like if you trim trees and the direct relationship to outages.

Some of it might be at the distribution level, but is there any metric we can look at for fewer standard violations or fewer little things that leads to fewer outages? Is that something that's been looked at?

It's kind of intuitive, but I wonder if -- as I said, I'm aware of some tree trimming research, but that's the only thing that I know of that comes to mind. But I think you've done some work on relay misops and how that effects -- I'm interested in any thoughts on, to make sure that we actually have the leading indicating standards right.

MR. CAULEY: I think -- I appreciate you pointing out that at least in the slice of risk that's the observable piece, events happen, we can unravel them and see what happened, we are able to pick out very specific things that we can laser focus on, whether it's vegetation management, circuit breakers that fail, the relays and misoperation or human error. And we've been able to target those, and we're seeing measurable difference.

The question is, how do you translate that into other areas? To some extent, it's my suggestion -- you know, I don't know -- as somebody mentioned earlier, most of the big events are weather-related, the vast majority. And I think Mr. Eto said it was -- most of that was distribution.

But I think within our role of reliability assessment, we can certainly dig deeper and get more granular about what the specific causes were, try to highlight those to see if there's opportunity because I think the slice of the pie that we're not currently focused on, which is the weather and resiliency area, is a bigger piece. And I think there's an opportunity to be able to shine a light on that and provide information that could be actionable, whether it's at state level or by companies or by whoever would respond to that.

COMMISSIONER LA FLEUR: Even though we can't control the weather, although potentially by being more attentive to global climate change we can have some impact on the trajectory of major events -- although that's way outside my field of academic competence. But I mean, we can't control weather entirely. That's certainly true. Aren't there things we can do, though, in the way we design the system, the way -- when I used to run a distribution company, if you trimmed your trees more, you'd have fewer

outages when the big lightning storm or the big blizzard happened.

So aren't there things you can build in ahead of time that make you more resilient to the weather, knowing it's going to come? I guess it's obvious, but I mean, are there things that -- in the bulk electric system that fall in that category?

MR. CAULEY: I think in the bulk electric system, one thing that we did do, it was a very long five-year effort, was basically the restoration of the rights-of-way to their design was very important. I don't know that I'll ever get a count, but I can get credit for improving storm resilience because the rights-of-way are cleaner, but I believe that has been a consequence.

And I'm sure that Mr. Koonce would probably have -- because I know Dominion has been very aggressive in building resilience in his parts of their system, and I think he would have probably some better examples.

MR. KOONCE: Well, first, we have been very conscious about building resilience in for the last 10 years. Now, we've had the benefit of a growing electric marketplace. Northern Virginia, central Virginia, and eastern Virginia have grown substantially over the last 10 years. So as we've been able to meet that demand, we've been also able to sort of build in resilience, split

substations, and standardize transformers and spare equipment and the like.

But it's interesting, Mr. Eto talks about distribution. We have a proceeding at the State Corporation Commission of Virginia today where we're asking the State Corporation Commission for permission to underground distribution circuits. We have 37,000 miles of distribution circuitry overhead, 57,000 miles total, 37,000 miles overhead. And if we'd take 4,000 miles of those distribution circuits and put them underground, we'd take 60 percent of the outages off our system.

So you know, at the distribution level, I agree with Mr. Eto. I think the distribution level is really the area where neighborhood trees ensnare crews for days.

Now, on the transmission system, I think the NERC standards on tree trimming and reliability is absolutely appropriate, and I think that's had a huge impact. But I think the next layer of reliability improvement, I think, may come at the distribution level, and we're trying to take steps to make that happen.

MS. HOFFMAN: If I may add to that, through the Recovery Act, I think some of the success stories that we've seen in some of the -- measurement area, but also in the outage management systems which automated switching. And so from that perspective, it's alloyed for better

containment of some of the events which Gerry referred to as a priority moving forward, and I think some of that technology has added value, especially at the distribution system, because now from the outage management, faster restoration, I should say more effective restoration versus faster restoration, and at the end of the day what we're trying to do is as effective as possible.

COMMISSIONER LA FLEUR: I might also add, that some of the work that's going on to build more redundancy into the grid and make certain specific facilities less critical is important, although it's a tension between that and all of the facilities who are taken out of the grid at the same time.

The second area I wanted to delve into was the cost/benefit discussion. Commissioner Clark made the observation, not for the first time that we've heard it, that perhaps we should require a formalized cost/benefit analysis before the adoption of a standard. And I have not been a proponent of that for two reasons, but I wanted to get views from other people.

One is, because I'm concerned we'll build in another bit of bureaucracy into the process with all kinds of things people can fight about with every -- every time you build an algorithm, it could build just a lot of process in. But I think more fundamentally, because of the

structure with the industry voting on standard, it struck me in virtually all the cases I've worked on since I've been here that the Commission is pushing to have the standard be stricter, and the industry, not always but frequently, is pushing for more flexibility in the standard, in part to make it less expensive to deal with.

So I feel like the cost is -- the cost consideration is baked in in the industry vote. But obviously, you don't think it's adequate.

So I appreciate hearing more about that, or thoughts from anyone else because that is a -- that would be a big step, and it's one that keeps coming up at these conferences.

UTAH COMMISSIONER CLARK: Thank you for the question, Commissioner LaFleur. Certainly, I think your points are valid regarding the indirect consideration of cost in the development process and that that provides a measure of confidence.

But as I mentioned in my first statements, we're hopeful to learn more about how costs might be explicitly considered through this cost effectiveness method pilot that NERC is performing this year. So I look to that as, perhaps, a way to reveal, some way to address this that we don't yet understand and haven't yet been able to apply.

MR. CAULEY: It's really difficult for us in

this business. It doesn't lend itself like a single facility rate case where you have a line or modification to a standard. You have very specific characteristics and improvements, and you could probably get a request for proposal and have an idea exactly how much it's going to cost beforehand, and you justify that reliability benefit. If you look at a standard that we put into place, there may be hundreds to thousands of implementations and may vary the solutions across the industry. So pinpointing the cost/benefit is extremely vague and very difficult.

We do use, you know, the general concern and input from industry and stakeholders on the standard when we create it to make sure that it's as practical as possible.

I think ultimately it comes down to a policy decision. An example is GMD. It would be very, very, very difficult to really in any objective way to try to quantify the cost benefit of GMD, upgrade that we've proposed in the standard. But as a policy matter, if we figure it is necessary, we must defend North America from that issue, then our job is to figure out how do that as most practical, cost-effective, and beneficial way.

I think the cost study that we're working on is going to try to shed some light, but we should never think that it's going to being an exact science, that we're going

to prove every time that the standard is worth exactly that much money.

COMMISSIONER LA FLEUR: And I think it would be easy to cost-justify the GMD, because you'd hypothesize a huge problem, you'd say what it would cost, and you'd say oh, that pays for it. But that shows the difficulty of it, because how valid is that hypothesis, et cetera. It just goes right into the -- you know, you can make the numbers work. It's a question is, is it valid.

Roy?

MR. THILLY: Yeah. I agree that the costs issue is implicit in the voting process. Utilities care very much about the cost impacts, and they look at that when they review and vote on a standard. No one would say that we don't need a cost/benefit analysis, but to reinforce Gerry's point, it's very, very hard. You look at low risk/high impact situations, and how exactly do you come to that conclusion.

I think the issue really is, if a standard is determined to be necessary, what is the least-cost way to get that standard done. The difficulty there is the cost impact is different on different players when they're affected by the standard. So it's going to be very interesting to see how the pilot works.

The other thing I would say is, remember that

standards are not the only tools in the tool box. There are alerts. There's lessons learned. There's conferences. There's exercises like GridEx. There's a variety of ways to get at reliability issues that are not standards, and that's important to recognize when we look at cost.

COMMISSIONER LA FLEUR: Mr. Koonce, since I called you out as the secret cost of keeping the costs down.

MR. KOONCE: Well, thank you for that, and certainly, we are appreciative of anybody who really wants to weigh the cost of these things. But I do agree with you and, I think, my colleagues, that I think it does play out in the standard-setting process. And I think one example -- two examples.

One, GMD, we think that standard needs to be adopted. So here is a case where the industry says okay, this standard is before the Commission, and we -- we're ready for it.

Where you may see a different approach is in the desire to create a supply chain rule. You know, I look at that, my colleagues look at that, and that is so expansive and goes in so many different directions and could be so costly where one solution is we have to manufacture all the components that we use, and that's going to be impractical and very prohibitive. So I think what you're going to see,

depending on the subject, you're going to see the industry, I think, advocating comments, sort of different levels of either adoption or rejection.

And I think, you know, in the case of a supply chain, I think the amount of testing that we do and the way that we've set up the parameters around high, medium, and low, we think forms a good barrier. So in one case we will be for it and in one case we will probably object or put forward our views.

COMMISSIONER LA FLEUR: Thank you.

Dr. Ilic?

MS. ILIC: Just a couple of things on that. What we were proposing with our panel was to ask different BPS members provide information about what they need, what ancillary service they would be responsible. They should have a cost curve with that, needing or providing. So it's not market necessarily, but right away you get the bottom-up information about what is it good for to those who are ultimately going to use it rather than take some guess.

And the other thing is this issue about investment versus -- for robustness versus flexibility. I think it's a huge issue. So everything that we hear is let's build more and more. We can actually not build for resiliency. We have to either get some information again

from those affected on how much they're willing to cut their needs during the extreme events.

So -- and one thing -- he is not here, but for long-term investments, we really need some information from the states about what is minimal demand that needs to be supplied for the next five years. And so we build our investment for that rather than just build it up. So this information over different time horizons for resiliency, for adequacy of supply, I think it's essential. We are not necessarily talking about markets, otherwise, the risk at the end is distributed as a social thing and a finality and can never be mapped into who needs it, who's causing it. But there are relatively easy ways of fixing this, I think.

COMMISSIONER LA FLEUR: Thank you very much.

CHAIRMAN BAY: Thank you, Cheryl.

Tony?

COMMISSIONER CLARK: Good morning. As a kid who grew up on the Great Plains, I'm always interested in all these discussions about tree removal projects, because we successfully completed our tree removal project many, many years ago. So a couple of questions, and I think that they're both related to what can FERC do to help you in terms of a couple of the identified challenges.

Gerry, I was intrigued by your comment. Your biggest concern is anything that damages equipment,

especially certain types of equipment. And I've heard that refrain in a number of different ways, and it relates both to physical and cybersecurity, although it seems increasingly that I hear more about physical, perhaps, because of the complexity that can be involved with a cyberattack and physically damage the equipment, not that it's impossible.

So the question is, FERC's tools, as Commissioner LaFleur has talked a little bit about, has been these standards, which in some way are a little bit crude, and they -- and sometimes the request is always to make the standard more strict and more tough. But again, it's sometimes a crude tool. But it seems like a lot of the answer to this challenge that's been identified of how do we protect equipment is -- really relates to how do you diversify the grid so that an attack or anything that happens, whether it's a weather event or something else that's human-induced, that damage to any one piece of equipment is that much less important because you're that much more resilient across the grid, and so you're spreading out the risk. You're making any one piece of equipment that much less important.

Is there anything that FERC can be doing with regard to that specific question on how we make sure that it's not just about building fences around the most

important substations, for example, but ensuring that there isn't any one substation that that's particularly critical? And I'm -- it's something that's harder as a regulator to get your arms around to answer the question okay, what exactly should we be doing with regard to spurring that. But I'm curious if anyone has any thoughts about things that FERC could be doing to address that particular issue, these critical pinch points on the grid.

MR. CAULEY: Well, I think the Commission has taken a really critical good step with the physical security standard. And there was a lot of deliberation that went into that ahead of time in terms of what would be an effective standard and how would it work and address risks. So I think that was a great step. There's not another big next step, but I agree it's a concern.

In my time now, so it's -- you know, in the history of grid reliability, it's a very short time, but I've seen a shift toward thinking of standards and regulation of reliability as being about the operations and planning of the system, to really getting into areas around the physical characteristics and attributes and the toughness or the recoverability of the grid.

And I think the physical security standard was an example of that. Essentially, we're requiring some entities to identify critical assets and protect them.

And the GMD standard 2, which we're asking that you adopt, also requires -- it sets an outcome-based objective of protecting against a 100-year storm and says you need to harden, protect, and get your equipment in a position where it will withstand this kind of event.

So I think as we look at weather, as we look at physical taxes, as we look at EMP with severe events, the Commission is going to need to keep looking at, are there some outcome-based objectives that make sense for the public interest in terms of surviving, protecting, and recovering.

And I think, although I don't have a specific action at this point, because I think we have a lot of work in front of us, it is a line of thinking that I think we need to start getting our heads around, what is a sufficiently rigorous and robust grid, given some of the threats that we're trying to deal with.

MS. HOFFMAN: If I may add to that, I think your important message of redundancy is what the Commission should focus on. And as we look at dual fuel, the importance of dual fuel for managing and providing the system flexibility -- I would probably use the word "flexibility" in addition to Gerry's comments. But, you know, what are the options in which the system can react to things, whether you look at new technologies as power flow

control, you know, automated switching, as we want to make substations less critical. I think it's an ability to have redundancy and flexibility that's very important.

MS. ILIC: Let me just start by saying there is no single substation that is critical. I mean, it's a bold statement, but we can talk about it. You know, because there is always alternatives, the ultimate paths or -- so again, you know, it's flexibility. It's not that much redundancy. I don't know the extreme things, middle of the winter and dual fuel issue, that's maybe where we need to worry about redundancy.

But FERC really -- I don't know, this is my humble suggestion, should somehow find incentives to operate the grid more flexibly. It's been like -- I've served here over the last 10 years, I would say, on the several panels, on why utilities do not do optimization when they transfer power. You know, there has been so much documentation about being able to deliver from -- to New York City 1 gigawatt more than what we deliver now by simple different operation by TSOs.

And so -- and many other, you know, examples of that. When you have extreme event, it's even more serious, you know. The -- how do you give incentive to island and so forth.

So I think that is absolutely critical, because

the system cannot operate unless it's flexible, but there are no incentives for flexibility. All the incentives are ROI. So that's the end of that. So I -- whichever way that goes. Our little diamond proposal framework sort of says okay, maybe this is good enough, this information should be binding, you put the cost information on the ranges of these matrices, and if everybody has to obey that, then I think it may work.

But again, a lot of work needs to be done. There is no one single look at all the blackouts. There has not been one single blackout caused by a major thing that could have not been prevented. It's a cascade of things that you can prevent with flexibility.

MR. THILLY: Looking at further down the line, the jurisdictional line between FERC and the states, between jurisdiction of -- over transmission versus distribution, it's always been a bit blurry, but it seems to be increasingly blurry with the development of more generation on the distribution system participating in wholesale markets.

Getting the rules right and the protections right, we're all concerned about the reliability impacts of those changes, but if you look down the line, I would suspect there are reliability benefits to substantially increase distribution, distributed resources, demand

response, microgrids. So we have to figure out how that interface works, and that's, I think, going to take a lot of work between FERC and the states to get it right.

COMMISSIONER CLARK: Thanks. That's actually a great lead-in to the second question that I had, which is on this issue of modeling, especially as it's related to some of these other resources that are connecting on to the grid in ways that we didn't have in the past, my impression is that, for many decades, we have had the luxury of relatively plush reserve margins. And you could sort of just model the grid based on you had a significant reserve margin, you looked at the summertime peak, and there were things you did beyond that that were much more complicated than that, but it just sort of all worked. It was less tight than it is now. And so that raises the strain that we see in a lot of the comments that we've heard today, and I know are in some of the other comments for later panels, which is the grid is tighter, so we need more modeling, because we can't just depend on what we used to depend on.

So again, getting back to my question, are there things that FERC can do or FERC Staff in interacting either with states, as you suggest, or with industry, do to be helpful in collaborating with or encouraging that type of modeling that will allow us to get a better handle on the new, unique attributes of the grid that we have today?

MR. CAULEY: I will take a stab from the NERC view. This is sort of the -- one of the biggest under-the-radar unspoken issues. I don't make big speeches about it, but it's one of the things that concerns me the most at NERC. We are losing margin, and the loads don't behave the way they used to, and now the generators don't behave the way they used to. So we've actually started an initiative to grab synchrophasor data and basically re-create as many disturbances as we can to validate the models that we have.

So I think anything to encourage that entities or facilities connecting to the grid do have an obligation to participate in accurate modeling, provide the models to the transmission operators and balancing authorities and reliability coordinators and to participate that way. So it's -- to me, it's a future chapter in a blackout event, is we didn't know it was going to happen, because we didn't have it accurately modeled.

UTAH COMMISSIONER CLARK: Yeah. It occurs to me that Aliso Canyon might be the perfect example of this. Or if you just look at reserve margins in California in the past, you'd say oh, look, it looks great, and you've got plenty of capacity. But it's the day-to-day operations of the grid and how the fuel supply sources interact with that and the flexibility of the ramping capabilities.

MR. CAULEY: I just said, I think there's a new branch in the fuel supply that we've not modeled that we've not had in our planning standards, and I think there's an opportunity there with examples like Aliso Canyon to say, do we need to head in that direction in terms of not only plan the electrical system but your fuel supply and all the interdependencies that go with it.

MS. ILIC: May I just add one thing to that? I think that it is not a doable job by NERC or by top-down entities, these models and the characteristics of behavior must be provided by either nonBPS members or BPS members. It is -- let's say, to take some of these very complicated things like PPV, the power investors, there is no way that we can put these models into our conventional models that utility uses for standard stability analysis. This is why I think in my write-up there is a little part of grasp there on the information about different entities is not anybody's business. It is the interface's and how -- what are the ranges that can be met. It really doesn't matter, you know, this is inside the PV or wind as long as it does the same thing as seen by the operator.

So I think some cooperative, you know, process by which -- if you ask manufacturers, wind power manufacturers to give you the data, they will never give you -- they will never tell you what is the control inside.

But if you have a process by which we ask them, FERC and NERC establish some metrics that need to be shared on the input/output, that's good enough, and then the system operator can do many things on the seams.

So -- but I think the vendors and the TSOs, when they connect to TSOs and TSOs when they connect to the regional operators, they have to provide their characteristics. Large load also, you know. If you are going -- if you are claiming that you're going to behave that way and you're willing to pay so much for that power, then you have to have internal information yourself, informal internal control to behave that way.

So the burden of complexity goes to the end users rather than everything for NERC because I know that the PJM, many utilities have tried to model the mitigated details for wind power plant, but it's not a doable job. We need to have these multilayer model in the region which the right information gets exchanged. And if there is some rules of the road to pursue that, I think we can go a long way.

UTAH COMMISSIONER CLARK: Thanks.

Mr. Eto first and then Mr. Koonce.

MR. ETO: I think the advent of distributed generation and its growth is going to force a discussion that has really been overdue around reliability. And it is

about the distinction between what is public and what is private about ensuring reliability. Many industries have standby generation that allow them to ride through the disturbances on the grid.

I think distributed generation and some of the comments that Gerry made about the changing role of responsibility for reliability between the bulk system operators and the distribution system operators is going to be a very important discussion for the Commission to be actively involved and with the state regulators in terms of where does that boundary lie and how are the responsibilities, in effect, shared because it is an interconnected system. There's both what's public and what's private. And with respect to what's public, what is distribution versus what is transmission. And that's going to be a very exciting discussion for us to have going forward.

MR. KOONCE: I guess I would just echo what Marija and Joe and Gerry said. And I think Gerry said, if we can state the objective, and I think FERC can be very helpful in what is the objective outcome that you want, whether it's renewables integration or, for that matter, whether it's equipment sparing, I mean, state what is the objective or the outcome that you want and then work with the industry to kind of get to that phase because the

objective outcome is going to be different versus whether it's rooftop solar or utility scale solar or wind.

So I think working on what is the objective that we're trying to accomplish and setting that as a policy matter, I think, creates transparency between the Congress, the FERC, and the utility participants. And I think this is an important role that FERC can play in sort of helping set that objective standard that we all sort of understand and drive to.

UTAH COMMISSIONER CLARK: Thank you.

Secretary Hoffman?

MS. HOFFMAN: I'm not sure I want to bring this up, but I'll bring it up any ways. Key to good modeling is good data and sometimes I think we have to think hard about the data formats and data structures. And I know NERC has done that. From the meter data, just from our experience when we were looking at bringing multiple platforms in for customers to utilize meter data, it came down to the top 10 standards to have that data platform that would be ubiquitous and consistent across the industry so we can do building blocks.

Also, that visibility all the way throughout the system, I think, is important.

UTAH COMMISSIONER CLARK: That's great. Thanks, everyone.

CHAIRMAN BAY: Thank you, Tony.

Colette?

COMMISSIONER HONORABLE: Thank you, Mr. Chairman.

This was an illuminating panel. I appreciate your perspective. It sounded as though toward the end here we're all singing from the same handbook.

I have a couple questions for the two panelists on the end. Mr. Eto, I wanted to ask you more about the LB and L tool that's on your Web site to aid distribution-level evaluation of costs associated with undergrounding facilities, as Mr. Koonce mentioned. I'm particularly interested, as a former state regulator and not just a NERC colleague, but also because we know whenever we hear about a severe weather event we hear cries from our lawmakers and others about undergrounding our facilities. Also, because we know, as a number of you have stated, the lines are getting blurred. I think Vice Chair Thilly mentioned that. And I agree with Deputy Secretary Hoffman that we do have to pay more attention to what's happening at the distribution level. I'm sure that not only state regulators would be more interested in learning about that and objective ways to evaluate these proposals, but also members of industry who are having to evaluate the costs associated with it as well.

MR. ETO: I'd be happy to share more information with you about this tool. This tool is sponsored by the Department of Energy, and what it does is it assembles a lot of information that utilities have collected over the years where they've done surveys of their customers and where they've asked them what are the costs to their business might be for a loss of power at a certain time of day or a certain time of year. And so it's accumulated all those surveys and put them into a giant database and created a series of equations that allow people to post scenarios of -- for a given distribution circuit. If I have this many industrial, this many commercial, this many residential customers and the reliability of that circuit is, say, X and I want to change it to Y, what would be the change in the cost to those customers of the interruptions that I would be preventing by that investment.

And while it is not determinative of whether or not an is investment is appropriate, it's certainly a piece of information that can be brought into that discussion, one that I think is historically alluded to, but never quantified or spoken about in direct terms.

COMMISSIONER HONORABLE: Well, thank you. I hope to learn more about it, and I'm sure that in our journey and our work -- this is my first reliability technical conference, unlike Gerry, who has a number under

his belt. So I look forward to learning more about it and also aiding our state colleagues in their work. This is very challenging work, and we know that industry is equally challenged with keeping the lights on, doing it in a way that's cost-effective, and that meets that cost/benefit analysis.

MR. ETO: If I may just add two comments. One is I have briefed the Electricity Reliability Staff Subcommittee at NERC about these developments that have been sponsored by the Department of Energy, and we're actually working on a project right now. We talked to a variety of state PUCs that have some of these resiliency cases brought to them and asked them about the way in which economic information about costs and benefits figure into the decisionmaking process, and we hope those cases will be illuminating for the jurisdictions that are considering similar kinds of considerations.

COMMISSIONER HONORABLE: Indeed. And I harken back to the times that I've received applications for an unusual sort of cost treatment or one associated with resilience, and it is more challenging.

So thank you, and again, thanks to DOE for providing the tools that regulators need, but also that aid industry as well.

Dr. Ilic, you raised a topic that's something I

focus on frequently in my role as a regulator, seams. And you seem to propose something that could aid us, and I was intrigued, and I'm biting on your proposal that we could greatly eliminate or alleviate seams concerns by creating mandatory information sharing.

So I want to know, you may hold the key for us, Dr. Ilic, in resolving this issue. I'm intrigued by your position and any creative ways in which -- it seems very basic, but I want to hear more about how mandatory information sharing can maybe relieve or alleviate seams issues across RTOs or ISOs.

MS. ILIC: Thank you. I don't think I can answer that right now. But I would like to just mention a few things.

Over the years -- this is not just me now daydreaming and saying it would be nice to do. Over the years, looking back at different things that people have done in research, let's say you want to relax automatic generation control to add renewable resources. Now, what additional information needs to be done, what more detailed model will need to do. So we sort of -- it's very long process looking back. This is the lagging in research.

So we sort of learn that, you know, all these paths led now after so many years to something that's actually very simple, could be very simple. And we got

data from actually the Secretary of Energy when I was there during the sabbatical at MIT. He gave us dates. He was instrumental in helping us get data from the resource DyMonDS, which is in Portugal.

So we actually simulate a lot of these concepts on how different entities can be -- can imbed intelligence, what information needs to be exchanged. And it would be really nice to scale it down to bulk transmission system, because I think it generalizes.

I also should mention that at CMU we have these smart grid room simulator that we are developing in cooperation with NIST and you can actually simulate some of these things. Like if you model different parts, distribution, interruption with transmission, and you show -- you don't have to go to pilot experiments to actually first learn, if you were to exchange that information, what would be the next step and so forth.

So we are very excited about doing that simulator and the platform, but I have to say it's been a very long process, and maybe we are ready to -- you know, it's been all academic so far.

But the seams problem is -- it's primarily viewed at the general level between ISOs. But I think the one that is actually hidden here more are all the seams embedded inside. You know, we have so many TSOs, so

many -- inside the ISO, and instead you have TSOs and so forth. So those are seams, you know, we call them nested seams.

And I could -- I would be very happy to do more work and provide what we know on that. But that is -- I've been in this now for 30 years, teaching more conventional power systems and then -- so I'm familiar with the way the model power systems now reflect models versus if you were to model them as separable and then on the seams exchanging right information for different purposes, that's a very different thing that we have to do in this distributed industry. And so it's all work in progress.

But thank you for the encouragement, I would say, because I -- NIST has been really good about providing us with some minor funding the last three years. So we actually -- we would make this available to people who want to come and do the simulators of seams. It's doable at this point.

COMMISSIONER HONORABLE: Well, thank you. After hearing that explanation, I want to be even more enthusiastic about my encouragement because, yes, you are working in the academic community, but your work is very valuable because you are working in a different way to help alleviate these problems, and I think the modeling is only as good as the data that we have. So your role is key, and

I know, having worked with Granger Morgan and your colleagues at Carnegie Mellon as a member of the resilience round table in conjunction with the National Academy of Sciences, that you are very serious and very focused on this.

So I have nothing but time, Dr. Ilic. So we will be patient and wait on you to help us solve this problem.

MS. ILIC: If I may just add one more thing about objectives. Like you model things for analysis, but now we have to link them. Like these distribution companies have some objective, and it's subject to some physical constraints. So the models interact as different entities make their own decisions.

And I'll just a little bit link it with the electricity market. One of the things that comes out is the price of the decision; right?

So it's sort of natural link. You align the financial and technical together, two information. And I have done these for a while, but I think people are beginning to pay attention, and we are working close with NIST now.

COMMISSIONER HONORABLE: Thank you.

CHAIRMAN BAY: Thank you, Colette.

Any follow-up questions?

Okay. I would like to thank all the members of our first panel for your very, I think, very interesting and informative views on the state of reliability. So thank you very much.

Now we'll turn to our second panel on the emerging issues with an international perspective.

(Recess.)

CHAIRMAN BAY: Good morning again, everyone. I'd like to welcome everyone to our second panel today.

We have two special guests. We have Hector Beltran, the director general from the Unidad de Sistemas Electricos from the CRE in Mexico, and we have Dr. Klaus Borchardt from the EU Internal Energy Market, the DG for Energy, European Commission.

So thank you very much for taking the time to be here today to share with us your views on reliability issues from this international perspective.

So Mr. Beltran?

MR. BELTRAN: Thank you, Mr. Chairman, Chairman Bay, Commissioners and Staff.

I deeply thank you for the opportunity to appear before this Federal Commission, as one of the people responsible for developing the electric reliability regulation in Mexico. I've worked at the Energy Regulatory Commission for the past seven years, and now I'm witnessing

one of the major transformations we are having, not only in the electricity sector, but in the energy sector as well, not only electricity but also hydrocarbons.

So the information that I want to share with you are my personal point of views and doesn't really necessarily reflect the CRE's position and other Mexican industry.

I want to remark that Mexico is undergoing a sweeping energy reform away from power systems centered on a vertically integrated state-owned enterprise known as CFE, Comision Federal de Electricidad, and we are moving for a market in which competition is the basis.

And of course, we want to honor our target. We have very ambitious target for the future because we have to reach -- 35 percent of the energy that's going to be consumed in Mexico has to come from clean energy resources. Clean energy resources, we're including nuclear, large hydro, but mainly renewable energy such as wind and solar. And this target has to be met by 2024. So for the next eight years, we have a huge task, very ambitious path to move forward.

The reform emphasize two-pronged strategies from a structural transformation. First, we want to improve productivity to market competition and restructuring, and second, we want to reduce power production cost and

emissions because we want to increase the share of renewables in our system.

How is the Mexican grid and the work of framework changing, I think this is very relevant to share with you today, because we had a constitutional amendment in December 2013. After that period, we had a large serious discussion in Congress and finally now it goes 2014, the cornerstone, the legal framework of all these consideration and reform regarding electricity was shaped because we had electric industry act published.

Within this law, the new market structure, what's explained, we had the creation of a new ISO. We have new powers for different authorities. For example, the minister of energy, ourselves as the energy regulatory commission, and some other agencies that are going to play this important roles in shaping the way of the new energy market.

So after this publication of the law, CRE grew stronger. We have more authority, and we are now responsible to do more things than we used to. And one of those issues is availability because previously, energy reform, availability was operated by CRE. It wasn't entirely up to CFE, the electrical company, because they impose and oversee -- and oversaw all the compliance of such reliability standards. And now with the -- after the

energy reform, CRE, now they are responsible for or are the only authority responsible overseeing and imposing sanctions for not complying with these regulations on reliability.

But also, reliability is one of the major changes that we have had in Mexico. I want to share with you some of the key restructuring design elements. The first should be the grid planning and interconnection pools. We have changed the way in which interconnection from generators and also load centers have to apply to be interconnected to the system.

Now, we have a transparent and administrative process. Before the energy reform, this process was conducted by CFE. And now it's conducted by CENACE, which is the new Mexican ISO. And this is very important, because CENACE was previously a formal internal department of CFE. After the reform, this department was withdrawn from CFE and constituted as a formal Independent System Operator in charge of controlling and dispatching the system, as well as attending all interconnection applications from different generators.

So another point in the change is the way in which planning is done right now, because within the new process, SENER, which is the minister of energy, CENACE, CFE, and CRE are all involved in making this strategy

planning.

I think this is quite a change from the U.S. because perhaps there's no centralized national planning. You have to consolidate 50 different agendas from your country. Mexico is different because we only have one federal regulator, not state regulation agencies. We have CENACE, which is in charge of making these transmission planning strategies, looking at some principles like risk benefit analysis, cost benefit criteria, N minus 1 test, more stochastic approaches to receive the growing shares of renewables.

All those things are considered now, and CRE is involved, because we have to comply with some technical assessment regarding the technical and economic feasibility of such expansion strategies, because at the end -- all because how we are going to be recovered through our regulated target that is going to be imposed by CRE.

The second key element is the new electric regulation we have published right now. I'm glad to announce that the great code which is a cornerstone of the electric reliability in Mexico was published in April, like five or six weeks ago. And this is a first regulatory instrument that CRE has published in exercise of its new authorities and powers in reliability terms.

We are considering a lot of technical issues

regarding from planning, operation, cybersecurity, and interavailability for the smart grid for paving the way for its migrate in Mexico, as well as economic dispatch and some coordination between CENACE and the distribution company to surely operate the system.

I think it's very important to remark that in this new regulation about reliability, we have included NERC-like standards in the Mexican regulation. And why is that? Because of the electrical interconnection we have with the U.S., mainly the synchronous tie we have in California, and we have analyzed this from the Baja California-Mexico part, and we have included some that -- some standards that already applied before energy reform. And we have -- make all these new platforms within these new contexts. We have gathered, we have adopted these NERC standards, and now are appliable, are enforceable in the Baja California region in Mexico.

Of course, as our electrical interconnection is -- the number of electrical interconnection is going to be growing for the future, we're considering that more standards should be revised, should be adopted. It's not like a carpet-based answer.

We don't want to go in that direction. We want to take into account the Mexican topology of our system because mainly something that would work in the U.S. is not

necessarily going to work in Mexico, mainly because we don't have like these weather condition like snowstorms, tornadoes, or hurricanes. Instead, we have some other problems like monsoons, large rains, something like that.

It's not that we want to do this carpet-based approach. We want to do it in our best way. But of course, learning from the international experience, do not reinvent the wheel, but of course we want to make it in a more suitable way.

The third point is that we are having the long-term auctions in Mexico, which is really new, which is new process that we are living right now. The first option was concluded last -- in March, two months ago, and we were able to succeed.

And why I am saying that, because we want to try to acquire three different products through these auctions. We want to acquire capacity, energy, and renewable energy certificates. So we are using this mechanism to acquire those three products to our system, and as I mentioned, the first auction just concluded. These are -- this was a process conducted by the independent ISOs, CENACE.

And in the end, we were able to add more than 2000 megawatts of new capacity for only with PB solar and wind technology, which translate into an investment roughly about $2.6 billion in new and clean energy technologies for

the Mexican system.

Finally, I have been asked to answer a very important question today for this panel. What are the implications for the United States?

Well, I'm surely convinced of saying that those implications do exist and are significant. Two days ago just before I arrived here before you, the minister of energy presented this new document of our expansion strategies, and this is a very important exercise, because we think that document we are saying, what are the new infrastructure we are going to need for the future.

So the 2016 version of such a strategy considers various products to get United States and Mexico interconnected using HVDC lines. And what is more remarkable is that we are thinking about to build a huge project about interconnection corridor along the border with the U.S.

So I think this is going to foster our energy relationship, more implication for both markets are going to be in place. Of course, we see this as an opportunity to have more competitive prices in the recently born wholesale Mexican market.

So with these interconnections, we are also thinking about to meeting our clean energy goals. 35 percent is huge.

But also, I think some states in the U.S. could see these as an opportunity because you have the RPS in place. They may not be similar in all states that have it, but I think there's a chance to look at.

So -- also we have considered in the new regulation, even CENACE has mentioned, so the chance to sign international agreement with some other ISOs. Of course, we're thinking that this will improve reliability, because in American situations, some power systems who help each other and serve as backup. We came with this idea, of course, thinking about ISOs in the United States such as CAISO or ERCOT in Texas.

Last but not least, I want to deliver the message that Mexico is undergoing through a major transmission in its energy sector. The new regulation, developed already, includes the possibility of having imports, exports, linking the markets through all sides of the border.

Also, we have this new -- with a chance to look at international chances to improve reliability in Mexico. And of course, the main and the cornerstone of electric reliability in Mexico really was published, was recently improved.

And I want to take this opportunity to thank FERC, NERC, NARUC, WECC and all the U.S. entities who has

not only helped CRE in moving forward but some other Mexican entities, because we are ensured that we are moving forward in the right direction. We are meeting all the challenges we have with this implementation of this ambitious energy reform, which I'm sure will pave the way for full energy integration in North America.

That should be my remarks.

Thank you.

CHAIRMAN BAY: Thank you, Mr. Beltran.

Dr. Borchardt?

MR. BORCHARDT: Chairman Bay, the Commissioners, dear colleagues from FERC, thank you very much for having inviting me to this small hearing here.

Mr. Beltran has answered the question that was put to him at the end. Let me start answering your question, because my question was what lessons can be learned from the European experience of integrating renewables? My answer is for the moment, nothing.

And this is so because we are currently really in a very deep reform process of our electricity system, and we are -- as a European Commission, we are about to table the Commission's proposal on this reform and the integration of renewables into the market is one of the cornerstones of this reform. This proposal will be adopted in December and then tabled to our legislator, the European

Parliament and to the Counsel of Ministers.

So what I can do today is to give you a kind of sentiment in which direction we are moving in our proposal, and it has to be seen whether our 28 members states, notably the European Parliament, is more in the electricity field on the side of the Commission, but whether our 28 member states will follow the Commission in all in what I'm telling you here needs to be seen.

The context for the European Union is clear. The European Union has committed to continued increase of the share of renewables for the coming decades. And recently, in the context of the agreement that was reached in Paris in the COP21, the commitment that existed internally in the EU to reduce greenhouse gas emissions by 2030 by 40 percent has been even internationalized or globalized. So the U.S. committed to do this.

And this, of course, goes along with an increase of the share of renewables in the final consumption up to 27 percent by 2030. And this is not -- this would mean 27 percent share in final consumption, that about 45 percent of renewables would go into power generation.

And if I go even a step further, 2050, we have another, internal this time, goal which is to decrease the C2 requirements further with a share of renewables of 80 percent, which would lead to a power generation share of 60

percent.

So this is our -- these are our objectives, and the path that we are going. And it is clear that such a change in the energy mix in Europe has significant impact on market functioning and also on the grid operation.

The existing power systems and market design that was, I could say, only recently, about five, six years developed, was still closely linked to conventional generation. And now with the really incredibly fast development of renewables, not in all 28 member states but in a number of member states, we are really facing now the situation that we need to integrate the renewables into the market.

And I have distributed to you a presentation, but I talked you through that very recently and I will only allude to some of the slides. One you will find now, and two, because what we think is integrating reliable renewables requires new thinking.

And here on that slide, you have two examples. Typical situations that you can have, on the left side, you can see a situation with high demand and very little renewable production. So the winter day where the wind is not blowing and the sun doesn't shine. And in this situation, we have to cover, in order to meet the demand, we have to cover the needs then by imports, reduction of

demand of flexible generation.

If you go to the right picture, it's exactly the opposite. There, we have low demand and high renewables production, again a windy and sunny summer day, a Sunday, let's say. And here again, we have to cover the need with exports, increase of demand, storage, and flexibility.

So for both situations, what we need are flexibility options such as storage, demand side response, flexible generation, and interconnection import and export capacities.

So that is the setting, and now I will be very brief on the following one. You can follow it from the next slide. I have given you some slides where you see the current situation where we are to better understand where we are heading to.

The first slide that you see the EU energy system today. And I have taken out two very significant instruments. On the left side, you will see the current situation on our capacity markets proposals or existence in member states, I must say. This is a situation where member states themselves have created their own capacity mechanisms. Only the green countries, they are relying on an energy-only market. All the others, they have different forms of capacity mechanisms. And you can see that it delivers a very scattered picture.

And on the right side, you have the same situation with the renewable support scheme. You have quota obligations. You have feet in tariffs. Or you have feet in premiums. Again, you can see quite a divergence, and it is clear this cannot remain.

Please have a look to the next. It's a renewable cost as a share of electricity price. There, you can also see where you have a lot of renewables with Germany, Spain, Czech Republic. But you can also see that the cost of renewables and the energy price in Germany alone is about 16 percent, quite dramatic.

And the next one shows even an untenable situation, when you look at the cost-effective use of renewables, because there you can see on the wind energy onshore, that the support, so the subsidies for renewables exceed even, quite often, the cost.

On the right side, you have the same picture with -- there, you can see we have already introduced some reforms, not we from the European side but member states have done it because this is a very -- or was a very costly issue.

So that brings me now, having that in mind, what do we do. And on the next slide, you see two things we have to do for the integration of renewables. We have to make the markets and the grids fit for the renewables. And

on the other side, we have to integrate the renewables by changing some of the patterns that are currently in place for the regulatory framework for the renewables.

Let me have a short look into these two different things, but different, I would say they are two sides of the same coin. The coin is the integration of renewables. The one thing is preparing the markets to take in the renewables, but also then integrating the renewables themselves.

What do we do on the integration itself? There are three elements that are of major importance for us.

First of all, we want to make renewables subject to the normal market rules. That means in our current system that we have to get rid of the priority dispatch rule that exists for renewables, and we think that if all technologies have an equal access to the market, that already the fact that the marginal costs of renewables are close to zero will give them already the priority that they might need in the merit order.

So what we want is to abolish the priority dispatch for renewables and to move to a merit-order-based dispatch. That's the first.

The second important element is that we want also to bring all the renewables producers under the balancing responsibility. We think that the current

situation where only in some member states -- that's a national rule. We want now to put on the European level the full balancing responsibility also on renewable producers. Without that, we do not see that renewable producers have the necessary incentive for efficient operational and investment decisions, that is because they are not under the same threat, of course, that they have to pay an imbalance penalty and these kinds of things. So this is one of the major issues in this part.

And the third one is -- and that has to do with a slide that you have seen on the diversity of support schemes. We take the view the best of all solutions would be that we get rid of all subsidies, to be clear, not only for renewables but also for the conventional. We are on a good path for the conventional, but it is also clear we cannot take away all the subsidies from the renewable side. But it is also true that photovoltaics and onshore wind are mature technologies and they do not meet the same support schemes as in the start-up phase a couple of years ago.

So therefore, we want to regionalize, first of all, these support schemes, and regionalization means that we open it up also for neighbor countries. There's no national system anymore. We want to make it more market-based and open and fair competition, which means that we will impose auctions. And through auctions, the

right support level should be settled.

That has some implications because we have some test cases now in Germany, the most advanced country in terms of renewables. They have done the first auctions, and we can see that, all of a sudden, the old conventional incumbents, they are there and taking the major shares and the smaller producers, they fall out. That's certainly an issue that we have to address when designing this system.

So these are the three major issues that we have to address on the renewables side.

On the market side, there also is some issues that are important. The first and foremost, make better use of existing infrastructure. We have to go to a flow-based market coupling that we want to introduce that better reflects the situation at interconnection points. We want to smarten our infrastructure by introducing smart grids, also using digitalization, the digital internal market internal market that we are creating. The better integration of system operation here, we have done recently, just a month ago, a first important step, a network code on system operation has been agreed. That's a very strong step forward.

But more has to be done. I come to that on the next slide.

Clearly, the most important of all is that we

get a liquid balancing market right. And only then we can take really the advantages of resources across borders, and we can then have it cost-efficient transition to a low carbon energy system.

So in that respect, what we want to do, we want to create a coordinated balancing areas, so-called CoBAs. Here, within the CoBAs we will again increase the efficient use of interconnectors in a given area, and we will pool the resources in that area. And here, pooling in the way that we can exchange energy and the capacities.

The key issues, and I will only name them, but not develop on them, is single marginal prices we want to introduce. We want balancing energy gain closure time. After intraday, across solar gate closure time, standard production products. We want to limit the numbers of products in the balancing market on that. We want common procurement rules with shorter contractual periods with maximum of one month.

And last but not least, we want a standard imbalance settlement period of 15 minutes, which causes a number of problems, and we have already had some feedbacks.

The next slide you should have a look, regional TSO coordinators, this is also one of the hearts of the reform. You can see here that's the Commission proposal, and that's why I said I don't believe that member states

will like that when they see what we are developing here, but here, it's a good forum to present it.

You see there what we are having in mind is that we are only going for five regions within the whole 28 EU. Just for you to know that NOE, the European organization of the transmission system operators, they are dealing with 11. So we are much, much more ambitious than the TSOs on this.

You can see here on the map, I'm not explaining it in detail, but you see you have the central part, and you have the north -- northern part and the Baltics. You have UK and Ireland. You have Portugal and Spain. And then you have the south/southeast Europe as one zone.

And here, you can see they will be a regional balancing area with a regional balancing coordinator. They will do the regional capacity calculation. They will do the security coordination. And they will also do the generation adequacy assessment in the given region. So this is really a complete new thing that we are -- have a regional setup for this.

Finally, and I will close with that, we should not forget that integrating renewables into the market is linked also to two other things that I would like to address very briefly.

One is the system adequacy. And this is very

important in Europe, especially those member states that are advocating for having capacity markets that are looking at that. And in Europe, when you are discussing the adequacy, you can see that this debate is often based on concerns of lack of firm capacity.

But I would argue that the integration of renewables that require an increased flexibility in the system. And this, in my view, does not go together. The firm capacity, if you give it through a capacity market, will not deliver on the flexibility that we are needed.

That is also the reason why the Commission is rather reluctant towards these capacity mechanisms. We have now agreed that we will accept them, but only after having gone through a regional adequacy, generation adequacy assessment, based on a common methodology. So for the moment, each member state is doing it according to their own methodology, we are developing community-wide, and then only if through this assessment we see the need for safeguarding capacity in the future, we would then allow for a design.

And the second and last issue, very important and gaining importance is distributed generation, demand-side manage response, and storage. On the distributed generation, here we want to enable the consumers to directly react to price signals on the market.

And this -- both in terms of consumption and also in terms of production, so the posthumous that they do. What we want to do here is we want to install a fit for purpose smart metering system which enables the metering and also the settlement of the consumption close to real-time, and we want to allow consumers to step into electricity supply contracts with dynamic prices linked to the wholesale spot market.

Demand-side management response here, we are looking really to the U.S. because you have a lot of experience. We have less experience. And we are developing here now a reform framework, a general framework based with a center having the aggregators and developing it further. But this is something for us which will, in the future, play a very big part, important part in our flexibility of the system.

And then is storage, of course, is also one of the issues that we are looking into, not so much now in terms of legislation, but we have already, last February, published our strategy on storage for the European Union.

And my last comment is linked to the distribution system operators, the DSOs. Because we should not lose sight that at least in the European Union, 90 percent of the renewables are going directly into the distribution grid, which, of course, puts a lot of stress

on their grids. And what we need is, we need DSOs that manage their networks in a flexible and cost-efficient way.

What do we need? We need a performance-based remuneration for the DSOs. We need to define the conditions under which the DSOs may acquire flexible services without distorting the market.

An example here is storage. We will allow DSOs to run a storage system, but only for the balancing purpose, not to be part of the market with that.

And we will also look into the distribution tariff structure that needs to send accurate price signals to all the grid users.

So this is the part where we are very keen also to do something in terms of an institutional change. We will establish at the EU level a representation of distribution system operators at the same level as we have for transmission system operators and for gas. We will come also forward with an institution that represents the distribution system operators.

So this was really in a nutshell. Also, it was much too long, what we are planning. You will see the fruits of all this in December. And then we hope that most of it, most of it, will survive in the legislative discussion, and we hope that all this can get into force, becoming real as of the first of January of 2020.

Thank you.

CHAIRMAN BAY: Thank you very much. It was very interesting to hear about Mexico's effort to transform its grid and its market, very exciting. I look forward to a continued development of transmission between the United States and Mexico. I think that will be yet one more very tangible symbol of the ties between our two countries.

And certainly, it's very interesting to hear about the EU's efforts to integrate renewables.

A theme in the remarks that you each made was the way in which markets are being used by policymakers as a vehicle to help further reliability and so I was really struck by that aspect of each presentation.

So from your perspective, are there certainly market features that you regard as particularly important in helping achieve reliability within your respective grid and market.

MR. BELTRAN: Yes, I think the market has to be available to achieve long-term reliability target because we not only are reliant on the grid code, we are also thinking on capacity markets. We're thinking on protocols to buy power in emergency cases. And we're thinking also in long-term transmission signals to get rid of congestion, which means that we're going to have better economic dispatch. We're going to be using more economic units.

But we don't -- we want to make altogether -- take into account that reliability is of the utmost important. Even more that if we have to stop some merit order in the economic dispatch because of reliability issues, we're going to do so, because security and resource adequacy have to prevail, even over economic sense of the -- of operating the market.

I think that we have to better shape the whole system market in order to achieve a specific reliability target. And it's not that easy, I know, and even more for Mexico, because this is all new for us. We are moving from centralized operation of planning way, fashion, into a market environment in which generators can come freely. Transmission and distribution, of course, they are natural monopolies under the regulation of state. But at the end of the change, we have also retailers that altogether have to comply in harmony with these electric regulation. Again, I think the market is a tool to achieve long-term reliability targets.

CHAIRMAN BAY: Thank you, Mr. Beltran.

MR. BORCHARDT: This is a very good question. And if you asked that question in Europe in different countries, you might get different answers to this question because in Europe I can say we have not yet established really a common belief of what is the right tool.

You can see that in Europe you have currently two schools. This is the school where as Mr. Beltran just said, saying that we have to concentrate on a well-functioning wholesale and then also see the link to how it is dribbled down to the retail market.

And to do everything and most of the elements I have mentioned, to make this market better functioning, wit the -- also with the infrastructure that goes with it, also attracting new investments in production and infrastructure through the market, which means through scarcity pricing, allowing for scarcity pricing. That's one school, and I do not hide that I belong to this school.

Then there's the others, more, I would call it, the fringe school, and you know what is coming now. That is more the regulated approach. They have a deep mistrust in markets. And they say markets can only function when they are fully regulated, and there are no markets anymore.

So -- but anyway, that's their logic. And therefore, there you are going for capacity markets as really not something that comes at the end, but that has the same importance than the energy-only market. They want to install that as a second important pillar of their energy system.

And here also, I hope it came across, the Commission has more nuanced. We do not want that as a

second pillar next to the energy-only market. We want to have it as a kind of instrument of last resort. So we want to make sure that the market function as long as possible.

And we think in the European Union we have one advantage, that we have a number of member states. And if you look mostly to the central, west, northwest where you have a lot of potential, and if you get into this regional cooperation, you'll have a lot of natural balancing possibilities, if you have interconnections and this.

Another -- because Mr. Beltran mentioned that as well, another big discussion currently, and it's not solved, it is true that the European Commission and also what I have told you, that we say flexible market and short-term market. That is heavily criticized for the moment, and we are under huge pressure because they say for the reliability that the Commission also has to stronger take into account long-term contracts that you have mentioned. But our answer to that is, the long-term products are on the market, but they are not demanded.

So if you -- again, if you want to do it, you have to do it the French way, by imposing a certain percentage in the portfolio for long-term contracts. And for me, for the moment at least, this is not the scenario that I would like to see, that we interfere in business decisions and imposing a minimum stock of long-term

contracts in the portfolio.

CHAIRMAN BAY: Thank you very much.

Cheryl?

COMMISSIONER LA FLEUR: Thank you, gentlemen. That was fascinating.

I've been closely looking at what's going on in Mexico with such a big transformation going on and of course, we've been involved in a lot of pipeline cases to Mexico as well, which is a part of our relationship.

I'm interested, Mr. Beltran, with the increased interconnection that you spoke of between Mexico and the United States at the CAISO and potentially ERCOT regions -- I know right now Baja, Mexico, has a lot of AC connections and participates in the NERC world.

Do you see more potential to work together on reliability? Right now, we're much more involved with our Canadian neighbors on reliability, even though a lot of those connections are DC as well and I wonder if you think that might add value, going forward for you.

MR. BELTRAN: Great question. Definitely, we have been working together with some U.S. agencies.

Today, right now as I speak to you, a technical workshop on CRE headquarters in Mexico City is taking place. The staff from NUREC, staff from WECC, and also our staff are discussing technical issues on interconnection

between Baja, California, and the United States region.

Why is that? Because we are concerned about the monetary compliance, some audits that are going to be taking place next year, at the end of this next year, last quarter.

But of course, the more interconnection we are going to have using the HVDC lines, not only that technology, requires more coordination between both sides of the border.

Of course, we are aware that the ERO here in the United States is NERC. But in Mexico, CRE plays the role of FERC, as well as the role of NERC. So we are very ambitious in this issue, and of course, we're thinking of only working together with FERC, NERC, that we are already doing, but of course with some other regional entities, of course WECC and some other partners. And I think that a very good example of that fruitful relationship is that now in the formal regulation that is enforceable in Mexico, we have NERC standards included in our regulation.

And of course, the more interconnection we are going to have, it makes sense that we see duplication of other standards because we want to be very careful with this, because we're not going to look for some weather protection in case of snow. But of course, we want to see about power stability, power transfer capacity, some

cybersecurity issues, because these are really, really important for us. We're working together with CENACE, the Mexico ISO, who had the chance to receive high staff from NERC, and that really opened our eyes, because cybersecurity is no longer some fiction or something that we can only see in a movie. I think we have to be prepared, and the first step we have to take is that -- the awareness that we already had, but now how we can move forward in order to be absolutely protected against that threat.

In the Mexican case, we haven't had these cyberattacks in the power sector. I am aware of where they have occurred in the financial markets and some system of personal information, you know. But in terms of energy infrastructure, we haven't had these cyberattacks.

But we don't want to have a reactive position, like oh, we suffered from a cyberattack, now what do we do next. We have to take a step in advance and be as prepared as possible to manage these kind of situations. But definitely, coordination between U.S. and Mexico is needed, because we are going to be more and more interconnected through the border and exchanging more and more energy through both markets.

COMMISSIONER LA FLEUR: Thank you very much for that. I hope we can find ways to work together while still

respecting the differences and the concerns you have. I know we heard earlier from Ms. Erickson from Alberta, who said that when things get adopted, then she looks at them or the other officials look at them and decide if they have any relevance there. And it sounds like there are some parallels.

Mr. Borchardt, there were so many parallels between what you talked about and what we are going through, trying to reconcile effective markets with environmental goals and having strong member states with different resource adequacy structures and preferences is something that's very much the case here.

I'm interested, as you look forward, when you have -- obviously, you have your -- you started right off with the renewable and the carbon goals that you have. But it's not just a matter of attaining them but doing so with reliability and cost effectively.

What do you see as the biggest challenge, big picture, as you get from here to there? There's just so many moving pieces.

I know earlier Chairman Bay had asked what keeps you up at night. But what do you see as the biggest thing that could keep it all from coming together?

MR. BORCHARDT: First of all, allow me that I would like that the EU joins you in cybersecurity issue,

because for us it is also something that we are looking at, and we had a cyberattack two months ago, I think, in Ukraine. So I think no system is really resilient yet. I think the more we exchange best practices there -- and the EU would also be interested to contribute to that.

Now, what keeps me awake at night in that respect, there are many things.

First of all, it is still that in electricity and electricity market, the system based on 28 different, still very, very diverse, national systems is very difficult to handle from EU level. You are rightly referring to our targets that have been endorsed by everybody, but I should also say that, for instance, 2030 target of 27, at least 27 percent has become a European target. The first one that runs out 2020, the 20 percent have been broken down at member state level, and each member state knows exactly what they have to do. Now, the 27 is an average at the EU level. And there is one of the big, big problems.

What are we going to do if we do not reach that? Because some members states, I could mention here Poland, are not willing to contribute because they are completely back into coal.

Then how do we fill the gap? What is to be done there? That's one thing.

The other thing, I think I mentioned already is, we are convinced that we have to get this regional cooperation right, but our member states following us there is questionable. That's a second issue.

The third issue, and that has to do with cost effectiveness, is the support schemes. There's also a lot of nationalism in handling these things, because if you open up these systems or if we have a capacity mechanisms, we will also insist that it is accessible for companies from other member states. But there you have the big questions that the member states will say why should I pay a company -- let's say it's a capacity mechanism in France, and France will say, why should I pay a German company to sell into France energy. They can export it anyway, but why should I pay twice, the market price and the capacity remuneration, why should I do that.

So these are three of the issues. I don't think that on the other issues that I have mentioned, especially creating the balancing market with the integration of renewables, the balancing responsibility, or even, I would say, go for scarcity pricing, that these are hurdles that we could not overcome, but it is more the politics behind it, which comes out in support schemes in regional cooperation in that sense and how to really get to the targets when you have European targets and national

targets.

COMMISSIONER LA FLEUR: Thank you very much. Now it seems even more that we can learn from each other.

Thank you.

CHAIRMAN BAY: Thank you, Cheryl.

Tony?

COMMISSIONER CLARK: Thanks, Mr. Beltran and Dr. Borchardt, for being here.

It seems we have more physical linkages with Mexico, of course. But I think in terms of intellectual linkages, all of us in the regulatory community have an awful lot that we're learning from each other. And I'm reminded of how much I enjoyed this conversation harking back to about six weeks ago, a little over a month ago, I had the opportunity to represent the Commission at the EU/US dialogue that was held in Madrid and greatly enjoyed that, and we covered a lot of these similar topics. And we really all are learning a lot from each other, especially on those areas that you identified, cybersecurity and market design issues and integration of variable energy resources.

In the interest of time, I'll limit myself to just one question, which is for you, Dr. Borchardt, and it's this. About, I want to say, maybe two years ago we had a -- there was a German delegation that visited us here

in FERC, and they were talking about this issue of capacity markets, and there was a great deal of discussion about what to do. And you've spent some time talking about that here this morning as well, and some of the potential obstacles to developing capacity markets in, say, Germany or Europe.

One area that I don't know that I heard you talk about, but I'd be interested in hearing you speak about a little bit more in relation to capacity markets, is this issue of subsidies. And to what degree there's been an analysis of, if you're going to have capacity markets that challenges that subsidies, in particular, bring to those capacity markets -- you've talked about some of the other challenges to implementing a capacity market.

And the reason I ask is because in the discussion I had a few years ago, and we've had functioning capacity markets here in the U.S., for better or worse, and we've sometimes tinkered with them here a little bit around the edges where we think there may be some challenges and tried to improve them in terms of capacity. But the one takeaway that I offered to the German delegation was I think it's really tough to have a very subsidy-laden system and just layer a capacity market on top of that. You may be buying yourself more problems than it's worth if you do that.

And I'm wondering if this tension has been explored more fully.

MR. BORCHARDT: Yes. First of all, I would like to echo what you said. It's true that we have no technical or physical connections, but intellectual connections the more, and therefore, I really welcome or we really welcome the recently signed administrative agreement between FERC by the chairman and the director general, DG Ener. So we now have a platform where we can have this exchange, and we are all very happy about that.

On your questions, yes, there is this tension, and we've even had this tension within the Commission. I'm being very frank with you here, because initially when we addressed the capacity mechanism issue, certainly my idea was that we should overcome our dependency from competition law. We should have our own enforcement instruments and procedures.

For instance, when I said the first step is the generation adequacy assessment, that result, I want it to be notified to the energy sector, to us, not to DG competition.

Internal discussions then have seen this tension because they have said and they have done a second inquiry on the assisting one, you might have seen that on all capacity mechanisms that are currently in place in the

member states and none of them is compliant, none of them is compliant with EU competition rules. In internal discussions we have finally decided that we will leave it to the competition authority, through state supervision, to follow up on capacity mechanisms or capacity markets that might now be installed.

There are already guidelines for state environment and energy, and they tackle also the capacity markets. These guidelines have to be renewed also as of 2020. And what we are now doing, DG competition and DG Energy, we are sitting together in working together common criteria, cross-order participation, for instance, technological or neutrality regional approach. All this we are working out together so that in the guidelines and in our legislation you will find merit conditions, but the enforcement will then still be done through the state supervision. That's the compromise that we have.

COMMISSIONER CLARK: Great, thank you. I didn't think it was -- what you're learning and what we're going through is very similar in a lot of ways in terms of issues related to out-of-market solutions that might be done at one level of government and reconciling that with wholesale market regulations at another, in this case, capacity markets. So I think we're learning from each other.

MR. BORCHARDT: It is interesting that you have

mentioned Germany. I can tell you where we are with Germany, because they are against capacity remuneration, but they have set up reserve. They call it a reserve. The reserve, that is not a strategic reserve, they say, because they believe the energy-only market will do it, and it's only there for being there. And then they have put 3 gigawatts in there.

And now it is now with DG competition, and DG competition says how did you get to this gap, capacity gap of 3 gigawatts. No answer. So the answer that I got from Berlin was oh, yeah, the minister for energy has three friends, and for each one a gigawatt. And you can imagine that they have problems now in Brussels with DG competition on this model.

CHAIRMAN BAY: Thank you, Tony.

Colette?

COMMISSIONER HONORABLE: In the interest of time, I'll make two comments very quickly.

Director-General Beltran, thank you for being here today. We all have been watching with excitement your very ambitious effort in Mexico. As I mentioned earlier, I look forward to hearing more and engaging more with Francisco Salazar, my dear friend, and most of all, we are rooting for you, for Mexico, because you are undertaking this effort, but also because we are interconnected, and

I'm very pleased about the ways in which FERC and the CRE have worked so well together over the years, and I look forward to our continued work together.

So thank you to both the CRE, the CFE, and others who continue to visit us as well and keep us apprised of your work, and we look forward to our future engagement.

Dr. Borchardt, I was really taken with your humility when you first began speaking. Lord John Mogg is a very, very dear friend of mine, and he would never sit at that table and say that we have nothing to learn from the EU. So I will tell him that he should take a page from your book.

But in all candor -- they're laughing, because they know John as well. In all candor, we have a tremendous amount to learn from you. I think our colleagues have mentioned a couple of things. One that I noted on a tour that I took there some years ago focused on renewables integration was how strong your R&D efforts are, as well as your public/private partnerships. And I continue to be fascinated really by how well it's evolving and even had the opportunity to tour Red Electrica.

So I'll be interested to see how your reform plays out and how it impacts operations and grid maintenance and really just transmission planning and cost

allocation going forward.

We, too, value -- I'm delighted that you mentioned the MOU. I was appreciative that the chairman invited me to participate in the signing with your Director-General Ristori, and we look forward to our continued work together. It's a partnership that we enjoy with you both, it's very strong, but I must say, with our EU colleagues, it's one of the strongest. So we'll work with you, Mexico, to strengthen that as well.

Thank you both.

CHAIRMAN BAY: Thank you, Director-General Beltran and Director Borchardt.

We will now take a break until 1:30. The schedule said 1:15, but we'll extend it to 1:30.

Thank you, everyone.

(Whereupon, at 12:33 p.m., the technical conference was recessed, to be reconvened at 1:30 p.m. this same day.)

AFTERNOON SESSION (1:31 p.m.)

CHAIRMAN BAY: Well, good afternoon, everyone.

Let's go ahead and get started with part two of our second panel, which is examining "Emerging Issues." This panel will be looking at changes to our nation's resource specs, whether it's renewables or distributed generation resources, and microgrids and the like.

And so without anything further, let's go ahead and get started.

Dr. Shahidehpour?

MR. SHAHIDEHPOUR: Thank you very much, Mr. Chairman.

My name is Mohammad Shahidehpour. I would like to highlight in my presentation the use of distributed control transactive energy and microgrids as a way of managing the power system reliability resilience, economics, and security.

I believe that this discussion is very similar to the days of using landline versus wireless phone where there are many people who were arguing that the landline system was practical and usable, what was the purpose of using wireless technology. And we have seen that the advent of wireless technology has truly revolutionized the way we use the telecommunications system.

In general, the large integration of renewable

energy can offer a number of benefits in processing generation transmission, distribution, and delivery, including the fixed costs of electricity delivery, pollution-free and often quiet sources of energy, supply of energy that's competitive with the costs of thermal energy, minimum contribution to greenhouse effects, and a modular and expandable sources of electricity with minimum T&D costs for resilient purposes. Application of smart grid and the use of demand response in electricity markets can maximize and leverage potential benefits associated with variable renewable energy and distributed energy resources.

I would like to emphasize that the smart grid technology refers to providing credible data to customers and sharing useful information by all stakeholders in power system -- for power system operation and planning.

In practice, microgrids are introduced to address the emergence of a large number of distributed energy sources and distribution power systems which can ensure optimal operation of potentially identical power grids, microgrids generate, distribute, and regulate the flow of electricity to local customers, representing a modern small-scale power system with a high degree of flexibility and efficiency in both supply and demand sectors.

Microgrid also allow customers to share the risk

of supplying the critical loads with local utilities in return for receiving more reasonable electricity rates while using transactive energy at peak hours.

During main grid disservices, microgrids can be transferred to islandable systems and interruptible -- funding interruptible supply of customer loads is offered by local generation resources.

By islanding microgrids will be resynchronized with the main grid once the disturbance is removed.

Considering the process in reliability basically, I want to point out that there is a significant difference between reliability and resilience. We use those two terms quite interchangeably, but reliability refers to high probable/low impact events; whereas resilience refers to low probable/significant impact.

In general, electricity grids is often designed and operated under a given range of critical conditions and able to withstand credible contingencies. Traditionally, the main source of reliability enhancement has been on N minus 1 or N minus 2 outages. However, low impact outages could potentially be followed by insufficient awareness or preparedness for resilience.

Hurricane Sandy, for instance, was an N minus 90 contingency. Long Island lost an entirety of its tie lines to Connecticut and New Jersey, and New York City lost all

its ties to New Jersey. The hurricane left about 7.5 million people without access to power within 15 states.

At the same time, the only section of the power system that remained energized were the ones that were equipped with distributed systems and controllable microgrids. Widespread outages in the wake of such natural disasters can light on the fact that resilience cannot be ensured, but deterioration can often be controlled locally at a tolerable level until full service are recovered at a large-scale level.

Also, microgrid application promote the use of more efficient DC systems in which renewable resources such as PV are regarded as DC, and much of the loads such as LED lights are regarded as DC. Modern societies are often developed based on interdependency of critical infrastructure such as electricity, communication, transportation, natural gas, and water.

The potential for cascading outages can lead to numerous supply problems in such infrastructures. The control and management of such large interdependencies could necessitate sophisticated modeling and simulation tools. In such cases, it would be distributed micrograph, is considered as a manageable energy hub where interdependency of energy carriers are installed, converted, and contributed.

I would like to point out that the use of microgrids, though challenging in the United States, has been more widely considered a viable option in developing countries for the expansion of large and centrally controlled electricity grid in newly developed load centers is considered a formidable task.

I traveled quite a bit, Mr. Chairman, in various parts of the world, and I see in places, including the U.S. Virgin Islands where the price of electricity is over 50 cents a kilowatt-hour, the use of distributed systems and micrographs could be quite important. Also, in parts of the world, like in Africa, where building a centralized and rather large electrical power system in troubled part of the world is something that governments will not ever consider.

I think the microgrid can be very efficient in various parts of the United States, in particular, in the Eastern Seaboard where we have issues with the resiliency. And I hope the notion of distributed system and microgrids could be considered more seriously in the United States as well.

Thank you very much.

CHAIRMAN BAY: Thank you, Dr. Shahidehpour.

Chantal?

MS. HENDRZAK: Hi. My name is Chantal Hendrzak,

and I am the executive director of market evolution at PJM.

So I wanted to talk first about probably the key thing you will hear me say over and over throughout this brief discussion for now is about transparency and coordination. And when you get that and you start with those basic building blocks, then you could build on to bigger and better things as things are desired and reach optimization. So I think this panel is a great example of just collaboration and coordination and sharing information across industries, across disciplines, across countries, and the things that we are doing and facing.

And we have learned from each other and certainly learned from the experiences that we all share. PJM has greatly benefited from the coordination across industries from working with the Department of Energy. And doing some of the studies on the Eastern Interconnection Planning Cooperative, for example, has really helped us inform on the gas electric infrastructure and sort of where we stand with that and looking forward, as well as earlier mentioned the synchrophasors and getting that technology installed, which is certainly something we are starting to incorporate now.

But then as we start wanting to get more and more transparency and visibility into what's going on in the grid, not only at the transmission level but then at

the distribution level, that may as well play a role. So we are already seeing where that collaboration has been helpful and may continue to be going forward.

In terms of distributed energy resources and microgrids, from PJM, from a regional transmission operator's perspective, sort of seeing firsthand the benefit and knowing what is out there, it doesn't necessarily mean direct control right out of the gate by any means, but having that visibility and awareness and seeing it.

So two examples personally that I was able to witness was back in the hot weather of September 2013, during the outage season in the fall we had very unseasonably warm weather and experienced a series of several local load sheds. And there were two days in a row where we had to shed load in the Pigeon River out in AEP territory. And on the third day, conditions still persisted where we found a 6-megawatt behind-the-meter generator in the city of Sturgis that we were able to, once we identified it and found out who we could talk to to find out what it was doing and if we could turn it on, saved us from that third day needing to shed load again in the same area. So there's a pro in that it was there, but a con that we didn't know about it two days earlier.

Another example being last April here in the

D.C. area, we talked about the low-voltage event. The benefit in having uninterruptible power supplies and backup generators that a lot of the load could -- fell over to and continue running. But the challenge in wondering did we lose the load, is it on backup in the reconnecting of it, what was -- how did that happen. Some of them needed manual intervention to connect them back.

And if you have a lot of these sort of microgrids or distributed energy resources and they start to cluster in one area, as you're restoring the system, it's really important to understand where they all are and how you can synchronize so we don't come up and come back down, come up and come back down, because we're not aware of what's out there.

So back to that transparency, knowing what's out there, how it's behaved, what is it's criteria for operation, just so we know how to plan for it.

And then once you see it and you know what's there, then you think about how do we take it to that next level in terms of how can we depend on it, how might we see it as being a reliable resource, either to reduce capacity or to use in emergency situations, use for ancillary services. That's when if you could figure out how to rely on it, which you could look at the markets as a way to do that, if you pay it to be there or pay it to provide you

information, then we sort of have this mutual commitment, give me your information, and I will pay you for the service you can provide. That would be a way to then go and optimize it and take it to that next level.

But it's certainly a challenge that we have in doing that, we've got some stakeholder groups going on right now, trying to navigate that very complicated path between wholesale/retail, is it FERC jurisdiction or state jurisdiction, transmission versus distribution. And where do we share that information. And Professor Ilic was mentioning that earlier. That's where it's very challenging, not only technically but then also from a regulatory perspective.

So one thought around an area where there might be some work that entities could do between the federal level and the state level and the utilities could be looking at, is there something like a model tariff, almost a template tariff that at the highest level you could talk about the high-level requirements that could be there from communication, from data, from frequency of sharing that information, and then tune it as you need to for the different states that you're in. We have 13 different states. So you know, could you then tune it to that level. So just some thoughts there on work that could be done.

And then lastly, on gas/electric coordination,

certainly as was mentioned in the past, we've come a long way since January of 2014, a lot of work and support from the Commission, and I agree with Pat Hoffman, said keep the pressure on. That's good. We definitely feel like there's support and value to working together with 787 enabling us to share information with each other. There's definitely more work to be done, but we think we're on a very good path with doing that so far.

So I will stop there for now and turn it over.

CHAIRMAN BAY: Thank you.

Mark?

MR. LAUBY: Thank you, Chairman Bay, Commissioners LaFleur, Clark, and Honorable, along with my fellow panelists. I'm truly honored and delighted to be here today.

The resource mix and its delivery is undergoing a rapid metamorphosis from large remotely located coal-fired and nuclear power plants toward gas-fired, renewable variable energy, distributed energy, demand response, and distribution-centric resources, along with demand. My comments will be focusing here on the identification of risks from the changing nature of resources, as well as its integration of distribution-centric resources.

The integration of large amounts of natural gas

generation amplifies the jurisdictional integration between natural gas and electric industries. Until recently, these challenges with natural gas deliverability were most visible during extreme weather, for example, like the polar vortex, and focused on the pipeline delivery. But now with the Aliso Canyon storage facility being out of service, it kind of really highlights the need to fully understand the natural gas single-fuel dependency issues.

NERC's recently released a report, or actually a short-term assessment, identifying certain protocols that resource planners and transmission planners can use to address these supply issues. Such protocols should consider the potential for large common single-mode, single contingency mode disruptions, including natural gas pipelines and associated facilities such as compression stations, wellhead supply, and gas storage. System planners must examine reliability needs to determine if the firm fuel transportation contracts are needed, or more units with dual fuel capability, for example.

Further, with the integration of large synchronous wind and solar resources, the character of the resulting system has to continue to support reliability. And you know about NERC's Essential Reliability Services report, and -- which that includes, you know, things like frequency response and ramping and voltage support.

And one potential solution is that smart controllers be added to these different types of resources so that they're enabled and capable of providing these kind of central reliability services. And that's something policymakers and regulators may need to adopt when they're considering 30 percent energy mandates, et cetera, from critical energy or renewable energy.

The secondary one to emphasize is the integration of more resources on the distribution system. We're seeing a continued accelerated growth in distribution-centric resources and distributed energy resources, which are often interconnected through the subtransmission or even located behind the meter. You know, with the smart grids and microgrid additions, system protection and equipment controls must be integrated in a well-coordinated fashion, while addressing the necessary cyber considerations.

In addition, operators may need information about the status of distribution systems, as you heard from many other folks here, especially around maybe imports and exports coming from that distribution system, maybe availability of central reliability services that can support emergencies. And also, as its evolution occurs, we start seeing reserve margin targets become less important and really more energy availability becoming more critical

in understanding the risks to reliability. Importantly, these resource additions to the distribution system highlights the need for the continued partnership between federal and state regulators, which of course, you heard in the first panel.

System resiliency is becoming an enhanced yardstick as well for reliability. And planning and operating a resilient grid will require more data to measure the system performance and forecast future system characteristics. NERC is developing analytical methods to identify interdependencies between events and resiliency performance. This includes integrating cyber and physical security into the planning and operations of the bulk electric system to be more robust for a tax in the future as well as being less of a target.

In conclusion, by identifying and quantifying emerging issues in the forward, you know, putting our binoculars on, we're able then to, of course, make sure that they never happen, and that shows the importance of the reliability assessment of activities that NERC has ongoing and the widely -- from the changing nature of resources and integration of resources and technologies in the distribution system need to be addressed to take advantage of the contributions to reliability.

So again, I wanted to thank the chairman and the

Commissioners, FERC Staff, and look forward to any kind of questions.

Thank you.

CHAIRMAN BAY: Thank you.

Mark?

MR. ROTHLEDER: Thank you, commissioners, and thank you for having me come back.

I was here two weeks ago discussing the Aliso Canyon situation. I was also on a panel last year on the reliability and some of the emerging issues, and at that time I talked about where California was in the process of integrating addition of renewables and looking at needing for central reliability services, as well as aligning market structures to meet the reliability requirements of the system.

I'm happy to say that we're in the middle of the process of doing such. We've had days where we've had 56 percent of our load met by renewable resources. If you want to consider hydro and nuclear resources, 71 percent of the load at times was being met by non-carbon-emitting resources. Those statistics are great, but the reality is, at the current state where we are, we still have a significant reliance on gas resources.

And I think the Aliso Canyon situation highlights that interdependency. Aliso Canyon is a major

gas storage facility in California, in Southern California. It feeds into the L.A. Basin, and it provides basically a shock absorber or a balancing resource for gas delivery to both residential/commercial customers, but also electric generation.

We performed an assessment earlier this year, and that assessment indicated that Aliso Canyon was not available for this summer. There was a risk for the summer of electric reliability, in which case, there could be 14 days in which we may be in jeopardy of not being able to meet electric load. Those conditions that would rise to that would be at times when there was a big, larger mismatch between gas scheduled and the actual gas demand on a particular day, overlaid with potential gas infrastructure outages, whether it be pipeline that they're doing maintenance on or testing or other storage facilities. Those combination events could lead to gas curtailments that could jeopardize our ability to meet electric reliability.

We've taken efforts to mitigate those impacts, including coordination with our neighboring balancing authorities, and as late as last week, we had kind of a summit between all balancing areas that we interconnect to in the west, sponsored by peak reliability, to discuss opportunities for helping each other out.

So I think the idea on Aliso is we recognize there is an issue, and we are now facing what we can to mitigate the impact.

Distributed energy resources is the other topic I want to discuss and here, we are beginning to see the beginning phases of additional distributed energy resources, whether it be 4,000 megawatts of distributed solar, behind-the-meter solar or additional storage and demand response. But the point is that we're taking proactive efforts to ensure that these resources that can provide resiliency, real resiliency to the distribution system are well coordinated and at least visible and able to be managed from the distribution or transmission perspective.

And in that regard, we've proposed methods to aggregate resources and have aggregation visibility and control over those resources. We don't have to measure and control every rooftop solar resource, but we have to have some level of controllability at an aggregate level. And I think the coordination -- and you've heard it before in other panels today, the coordination between the distribution system operator and the transmission system operator becomes ever more important in that regard as you have more and more of those resources in the system.

The last area that I want to highlight is the

importance of regional opportunities and regional coordination. We've seen the regional coordination benefits accrue in the last year and a half with the energy imbalance market. With the addition of Nevada Energy into the energy balance market we have new tools that actually can help mitigate things like Aliso Canyon.

That said, there's opportunities, wider opportunities for regional coordination, and those are the things that we are looking at and studying as a part of our efforts in California to see if there is -- what those benefits are and the mutual benefits to the west.

So I look forward to questions, and thank you for the opportunity to discuss these matters with you.

CHAIRMAN BAY: Thank you, Mark.

Now let's welcome Lorraine, who came all the way from Hawaii to be here. Thank you very much, Lorraine. We look forward to hearing about the experience that you're having in Hawaii.

HAWAII COMMISSIONER AKIBA: Aloha, Chairman Bay, Commissioners LaFleur, Clark, and Honorable. Thank you for this opportunity to be here.

For those of the folks in the room that don't know who I am, I am Lorraine Akiba. I'm a commissioner with the Hawaii Public Utilities Commission. I serve also on the board of directors of the National Association of

Regulatory Utility Commissioners and on the Electric Power Research Advisory Council.

My remarks today will address the potential effects and contributions that increased renewables and distributed energy resources will have on reliability. And in particular, I will highlight the lessons learned from Hawaii's experience and the innovations that have been developed to address reliability and resiliency for the integrated good of the future.

I will also view some of the regulatory guidance and specific orders that the Hawaii PUC promulgated in recent years to provide the strategic road map for Hawaii's utilities in transforming grid operations at both the transmission and distribution level as our state moves forward to achieve the 100 percent renewable portfolio standard goal for the electric industry.

Recent legislation that was enacted into law effective July 1st, 2015, increased the Hawaii renewable energy portfolio standards for the electric sector to a mandatory 30 percent target for 2020, 40 percent by 2030, 70 percent by 2040, and an aspirational goal of 100 percent by 2045. This legislation increased the established goals and shortened the time period for achievement of those goals.

Hawaii also has a mandatory energy efficiency

portfolio standard and the requirement for -- it requires incremental electric use reductions by 2020 and 2025 and a mandatory target of 30 percent by 2030.

The state's electric system, as you can see from the handout I provided you, consists of four electric utilities and six separate island grids, including the Hawaiian Electric company investor-owned utilities that operate the utility on Oahu, Maui, Molokai, Lanai, and the Big Island of Hawaii. The Kauai Island Utility Cooperative, a rural cooperative, owns and operates the utility on Kauai.

As you can see, since none of these island grids are connected, each island comprises an energy ecosystem within which system operations and energy balance must be maintained using a diverse portfolio of resources, including both conventional fossil fuel and distributed energy resources and renewables.

Hawaii has achieved recognition as having the highest level of renewable energy, in particular, distributed energy resources like rooftop photovoltaic in the country. Given the system peak load and the per capita base of customers on each island, as of January 2016, the Hawaiian electric companies led the nation in private adoption of rooftop PV with 77,000 installed solar PV systems across the island state, which represent 17 percent

of the customer base of which 30 percent are single-family dwellings.

Several thousands more distributed solar PV customers have been approved and are still awaiting interconnection on all islands except for Molokai, which has reached and exceeded its system capacity.

Adding to this mix, the utility scale wind and PV farms and planned community renewables facilities for each island. On Kauai, there are no wind plants due to endangered bird species. So the primary renewable resources for this island are both utility-scale PV and distributed PV, together with some biomass and hydro power.

State commissions, I believe, are, across the country, at the forefront of change. And the Hawaii PUC orders and major docket decisions in 2014 and 2015 provide policy and regulatory reforms to support the integration of distributed energy resources onto the grid and to provide incentives to utilize new technologies that enable DERs to provide grid services to support grid and system reliability.

Hawaii has been recognized as sending postcards from the future, I'm sure you've heard that, to the rest of the country, if not the world, by addressing distributed energy resources, community renewables, time-of-use rates, and demand response rates, and customer-cited energy

storage options.

We are also a living laboratory for innovation and implementation of innovations for good stability modeling and methodology. The Hawaii PUC Order 32052, Docket Number 2012-0036, which was dated April 28th, 2014, issued a white paper which has become known as the Commission's Inclinations on the Future of Hawaii's Utilities, and that provided specific guidance for future energy planning and review, including strategic direction for capital investments in the integrated grid.

The PUC also encouraged customer side and customer-cited technologies including DERs and distributed energy storage systems to support the grid. The development of integrated energy districts, as we call them, or microgrids, as some of the other panelists have referred to, with customers was identified as a means to provide customers with the resources to help integrate more cost-effective renewable energy onto the grid, while also providing resiliency and reliability benefits.

Another Hawaii PUC order, Number 32054, Docket Number 2007-0341, again dated April 28th, 2014, specifically defined energy efficiency, demand response, and energy storage, including electric vehicles, as distributed energy resources for generation purposes and incented the incorporation of customer-cited DER for demand

response and to be included in the utility's power supply improvement plans.

The Hawaii PUC Order Number 32053, Docket Number 2011-02006, again dated April 28th, 2014 -- that was a very key day for us -- adopted recommendations from our PUC facilitated reliability standards working group for integrating utility scale and distributed energy resource renewables in a reliable and economic manner.

Basically, the order acknowledged that system-level challenges related to renewables and, in particular, to rooftop PV, that these exist. The PUC also provided specific directives for actions to lower energy costs, improve system reliability and address emerging challenges to integrate additional intermittent renewable energy. The PUC directed the utilities to prepare energy storage utilization plans for all island grids to be included in their power supply improvement plans.

Given the high penetration of intermittent renewables, including distributed energy resources on our island grids, there are system-level reliability issues that can occur. And for example, more distributed energy resources generally display synchronous generation, and -- but also may require higher levels of frequency and our regulating response normally and traditionally is provided by that synchronous generation.

So in Hawaii PUC Order Number 32053, again Docket Number 2011-0206, the PUC reiterated so that people are aware of this, this system-level reliability, curtailment, and operational challenges on each island grid, not individual distribution circuit penetration levels, will ultimately become the binding constraint for distributed generation from rooftop solar PV on our grids, to make sure that people were aware of the system-level impacts and the need to plan accordingly.

And in response, our industry stakeholders and utilities have come together, and in a recent General Electric and Hawaii Natural Energy Institute, which is a part of the University of Hawaii reliability study, they explored how high distributed energy resource scenarios impact system reliability and the magnitude of contingency events, as well as how distributed energy resources may be utilized and enable to provide grid services to support system reliability, including frequency response.

In your handouts, I've attached pages from that study, and we'll be able to answer specific questions. But that study also outlined next steps in continuing analysis of actions to incorporate mitigation strategies and grid modernization with energy storage, electric vehicles, fast-acting demand response, smart inverters, underfrequency load shedding scenarios, and new operating

practices for conventional plant cycling requirements for spinning reserve adjustments.

At the Hawaii PUC in these ongoing dockets and in our distributed energy resources policy docket, which has gotten much acclaim recently where we have now addressed the ratemaking framework for distributed energy resources, we've tried to continue to provide guidance for resolution of technical challenges. We are also specifically considering new rate mechanisms for time of use and demand response rate, tariffs to incent customers to work with utilities for demand response aggregation from distributed energy resources, and new information, control, and communication technologies, the best from Silicon Valley as well, thereby providing ancillary services to support grid reliability and resiliency.

Thank you for this opportunity to provide information today.

CHAIRMAN BAY: Thank you, Lorraine.

Chris?

MR. MURRAY: Chairman Bay, Commissioners, Staff, and all panelists. It's an honor to be back.

Thank you for inviting me and to share with you the Navy's recent experience in trying to figure out how to increase our energy security and resiliency at our installations.

As a FERC detailee to the Navy, the views expressed today are my own and not necessarily those of the Navy or the Department of Defense. As a FERC employee, the views expressed today are not necessarily those of the FERC Commission or commissioners, but my own.

I currently serve with the Navy's Renewable Energy Program Office, which recently achieved the Secretary of the Navy's goal of producing or procuring 1 gigawatt of renewable energy by the end of 2015 to enhance our energy security and operational capability. Because of our recent successes, we're now also branching out into storage, microgrids, and electrification. Because REPO focuses on implementation and because we are a large energy user, to the tune of about $1 billion a year for electricity bill, my comments today will highlight what we have done and why.

At the Navy, we are seizing on the opportunity to work with utilities and other energy providers to make the grid more secure and resilient for our installations and the surrounding communities. Our primary mission is national security, and we need to ensure mission continuity in the face of any grid disruptions, whether they result from natural disasters, cyber, or physical attacks.

In just a little bit over 18 months, REPO brought, as I mentioned, the 1.1 gigawatts of renewable

energy into procurement, which equates to about one-half of our shore energy needs. Along with diversifying our energy portfolio, these projects are projected to save the Navy millions of dollars in utility bills through power purchase agreements, and they also, more importantly, have leveraged millions in electrical infrastructure upgrades using private capital, not appropriated funds.

And how did we do it? We used three simple acquisition models to achieve our goals in record time.

Under model 1, which you guys know as a power purchase agreement, we can enter into a 30-year contract to purchase off-base renewable generation for on-base consumption at rates that are equal to or better than current prices.

Under model 2, a third party can come onto our land, would build a renewables facility to supply load for off base. In exchange for using our land, they must give us in-kind consideration, which equals the fair market value of the land over the term of the lease. And the in-kind consideration can take many forms. We require that it helps improve our energy security through redundant express feeders being built, distribution system upgrades, access to the renewables during a grid outage, or smart inverters or other hardware that we would need to build the groundwork for a future microgrid at the base.

Under model 3, it's a combination of the first two. A third party comes onto our base, builds a facility. We consume that energy via a power purchase agreement.

Using these models, we have achieved some great success, and let me give you a few examples. In July 2015, we executed the largest ever federal power purchase agreement for renewables. A 210-megawatt solar facility will go operational later this year in Arizona and supply 14 California bases with a third of their load at a cost savings, a conservative cost savings of $90 million, using Bloomberg criteria, it may be upwards of 400 to $500 million over 25 years.

At Marine Corps Logistics Base in Albany, Georgia Power is building a 44-megawatt solar facility on our base that we will be able during a grid outage. In return, they're also building a redundant feeder for us for added energy security.

At Marine Corps Air Station Yuma, in trying to reach out to them for renewables opportunities, they cited an opportunity that they wanted to seek. They wanted to build a peaker plant on our base for their needs for their system. In return for letting us -- letting them use our land, they're going to build us a microgrid that will perfect that peaker plant. It will supply 100 percent of our backup power needs and eliminate the need for 42 diesel

generators.

While certain missions must always have access to power, we also know that it's critical for our surrounding communities to have access to power in times of need where many of our soldiers and sailors live. At submarine base in New London, the base, the state of Connecticut, Groton Utilities, which is a municipal and its parent company are all partnering together to figure out how to microgrid the base and also build a separate but parallel microgrid off base. So when Superstorm Sandy hits again, our nuclear subs won't be left at dock without any backup power.

The Navy, our mission is really focused on national security. We're a huge user of energy, but we're not into the business of electric reliability. That's why we need to turn to FERC, the utility's system operators, because you guys know how to do it better than we do. If you identify an opportunity that makes sense, if there's land on our base that you think makes sense, let us know. And more often than not, that land is going to be behind a secure perimeter with guards, which also can be good for a critical asset.

While most panelists today are going to talk about the need for increased transparency and communication, which is vital, there is a limit to that

transparency and communication in the realm of military operations and cybersecurity, as we all know. So if it puts our base at risk, we're not going to talk.

But having said that, we are marching down a path that most folks haven't done in the federal government, and we are looking forward to other opportunities. We still have another half of our load to buy through renewables. We have other battery and energy storage projects that we're pursuing, and things are changing, and we need your help.

CHAIRMAN BAY: Thank you, Chris.

Allen?

MR. MOSHER: Very interesting, Chris.

I'm Allen Mosher, vice president of policy analysis for the American Public Power Association. Chairman Bay, Commissioners, thank you for inviting me to be here, and thank you on behalf of all 2,000 public power systems in the United States.

The Commission is facing a daunting set of reliability challenges, but I think the current state of reliability is actually pretty robust. I think we've got positive trends pretty much across the board, and I actually think we have enough time to get things right, to address the sort of combination of reliability challenges, cost to consumers, meeting public policy goals, and

setting sort of -- providing the flexibility for the industry to come up with creative solutions.

Certainly, we're not in the situation that, say, Hawaii is in where they've already passed the limits and had to use underfrequency load shedding to deal with the problems of renewables. We're not in the same place as Germany. On balance, I think we've got a lot of time to work with it.

But we can envision within APPA a number of scenarios where the combination of state and federal energy policies and environmental policies could jeopardize electric reliability. I'm not saying there's a current crisis here. I'm just saying we need to watch things carefully, because in the process of institutional change, you can walk yourself into a corner and have unanticipated, unmodeled consequences. As modelers like Mark Lauby would say, we would be operating in an unsteady state and that's my primary concern.

For the Commission in particular, three messages up front. Number one, stay vigilant against threats and vulnerability to electric reliability that may be beyond the current design basis for the electric grid. Aliso Canyon is a case in point, but I'm pointing to others.

Second, the Commission should look closely at the interaction between federal environmental policies, not

limited to the clean power plant but others as well, that, working together with state policies, may, again, put us into that reliability risk.

Third, we need to look -- the Commission could reassess how it uses its electric reliability authority under the Federal Power Act and its -- other parts that are -- Part 2 of the Federal Power Act, how they work together to accomplish both the reliability objectives of the Commission and its responsibilities for just-and-reasonable rates.

I hope you will do that in ways, though, that again maintains the flexibility of the states to do what they need to do and for market participants to do so as well.

Regarding the specific questions the Commission posed, first of all, penetration of utility scale renewables is increasing, but there are large regional differences right now. We don't have to have national policies now. We may at some point further down the road. But there's time for regional variations. The problems of SPP, for example, are not the same as the ones the California ISO is facing.

Second, in distributed energy resources, they really have a much more limited impact on the bulk power system today. They're less than 2 percent of total

generation resources today. A lot of my members own them, in fact. A lot of them are diesels. They actually dominate in terms of total capacity. Rooftop solar, except in California and a few areas, is a small percentage of the total capacity out there. It's going to grow, but we have time to address those problems of integration and transparency that are so important.

And third, microgrids, I see that as a -- really a minor niche problem. I think it's going to grow depending upon the economics of that option, but we've seen the benefits of grid integration from every kind of technology of network integration. And planning for isolation is sort of the exception to the rule. It's a niche product for special applications and special customer needs that need higher levels of resiliency.

And my last point, and I'm going to end on time, is I think we ought to have further discussion about resiliency. We need to frame this in ways that the public understands they're going to be presented with a price tag they can't afford.

Thank you.

CHAIRMAN BAY: Thank you, everybody. It was very interesting.

One question I have is whether the most important technical challenge to integrating distributed

energy resources comes down to maintaining visibility or transparency or having a visibility or transparency and having some sort of control over that resource. It seemed to be a recurring theme in some of the remarks this afternoon. And if that's so, if there's this question of visibility and control, is it enough to have control over the resources that are aggregated, that are being offered into the wholesale market, or is something more than that needed?

MR. ROTHLEDER: This is Mark Rothleder. So I think the answer is yes, visibility and control are important. However, the more distributed energy resources you have, I think the more important -- what will start to happen is that how much control, how much of the resources are actually participating in the wholesale market and actually helping manage grid reliability may become an important issue.

And along with that is, what coordination is there between the distribution system operator and the transmission system operator. Because as -- at some point, if the distributed energy resources start to displace the grid connected resources that are being used for traditional control and reliability services, you need to ensure that there's sufficient quantity and capability in the distribution system, but then also coordination so that

when the grid needs to use those it's not conflicting with the distribution system.

CHAIRMAN BAY: Allen?

MR. MOSHER: I think it's important to differentiate between utility-owned, controlled, distributed resources versus customer-side resources. There's a real issue of sort of customer autonomy of something that's on their side of the meter and how that's used. This is really, I think, a relationship that needs to be developed between the distribution utility and its customers so that you get sort of a joint planning process that has mutual benefits here.

There, I think, on the rooftop solar side, I mean, I would agree that you could have some problems in high concentration levels if you don't have some level of control, at least the ability to limit the output for both distribution system operations and bulk power system operations.

But really, if we do the economics right, we're going to see a lot more distributed photovoltaics at the community level, because it costs half as much as the rooftop. The rooftop is an artifact of bad ratemaking design in many ways.

So it really depends, if we make that kind of choice, then I think the operational problems will come

away. But if we don't, if we continue with rooftop solar as a primary commitment, then at some limit you will have to greater operational control at the transmission or distribution system level.

CHAIRMAN BAY: Lorraine?

HAWAII COMMISSIONER AKIBA: I'd like to address that in terms of a state that does have a large proportion of distributed rooftop, you know, solar, as a part of the generation mix now that the utilities have to deal with.

It can be controlled, and we're not making good enough use of the technology that already exists in those distributed generation resources. So a lot of that had to do with some of the technical requirements, the IEEE standards, the control technology. And I think it's not either/or. I think it's a combination of, and with the smart inverters and being able to control that technology, whether that's in a demand response aggregation type of resource, to then go into the transmission or bulk power system, it's doable.

But again, it has to be a balanced portfolio, as we can tell from the very limited energy ecosystem that our island grids provide. I think, as I've said, this is the living laboratory from which others can learn. You know, there's much more flexibility in terms of a larger mainland grid because you can, you know, deploy those resources in

an energy imbalance market and do other things that you can't do physically on an island grid.

But the technology is there, and the strategies, and it really does take regulatory policy oversight to send the right price signals, to incentivize the customers to work with the utilities, if it's distributed generation resources, and it's also the right balance within that jurisdiction of the portfolio of resources, so it does not create a strain on the system, but these renewables can be used as ancillary services, and they can be, we've proved that in Hawaii, they can be used as grid support with the right controls and the right mix.

CHAIRMAN BAY: Yes.

Mark?

MR. LAUBY: Yeah, I think I'll just build on what Mark was saying a little bit, and that is that as the balance here starts adjusting and you end up with more and more resources on the distribution system and you're starting to count on those resources to provide essential reliability services, frequency response, supporting the local voltage, ramping. You need to know how much is there because you're going to be counting on it; right?

And so I think the information flow about that, the kind of resources and the kind of dynamic characteristics that they have, an accurate model of

accomplice below perspective at least is also going to be very important beyond just the megawatts itself. So I think if you look at the whole thing as an integrated system, before it was one-way flow, now we're looking at, perhaps, a little more of a dynamic flow between the distribution system and the bulk system, the bulk system is needed there also to support reliability, and it's going to be counting on -- and other distribution networks will be counting on some of the centralized reliability services coming from those distribution networks.

CHAIRMAN BAY: Yes, Dr. Shahidehpour?

MR. SHAHIDEHPOUR: I want to sort of emphasize a point that was raised earlier, that we need to sort of differentiate between aggregated level of distributed energy, which is primarily managed by large utilities and ISOs, as opposed to very distributed and sort of like rooftop type of renewable energy. The discussion that has been made in various parts of the country regarding distributed system operators and distribution system platforms or the ways of managing those kind of very distributed energy resources, in a sense, it's going to be very difficult for ISOs and large utilities to figure out what's happening on some of these rooftop business or the battery in somebody's basement. So you need another level in order to be able to manage the aggregated load at the

distribution level.

So the subject of microgrid plays a major role in that respect, because you have sort of a virtual boundary around this sort of distributed load that can be managed in concert with ISOs and large utilities in order to manage the grid.

Basically, microgrids represent a controllable load in the sense that utilities will not know what's happening behind that meter, but people who manage the microgrid can work with the large utility at the time that additional control is needed. So in a sense, if you lose a large set of renewable energy at the aggregated level, controlling load is one way of managing the grid, and microgrids, which are controlled renewables, can play a major role in that respect.

CHAIRMAN BAY: Thank you.

Cheryl?

COMMISSIONER LA FLEUR: Thank you all very much for those really interesting presentations. I have a couple comments and a question.

First, Dr. Shahidehpour, I'm glad you used the term "islandable microgrids," because I think sometimes there are misconceptions about microgrids and how they operate. And I think when you were speaking about Hurricane Sandy, you were referring to the Princeton

University microgrid that was used to support public safety, and it was very important in that instance. Maybe not, but I thought possibly.

And what -- the point I wanted to make, I think it harks on something that Allen Mosher said, which is that in order for the microgrids to be there when we need them for reliability, they're highly dependent on the markets, tariffs and everything else.

When I spent a day with the folks that run the microgrid, they knew more -- at that time I was brand-new as a commissioner -- than I did about the energy tariffs and demand response and frequency regulation. And they basically said to me every PJM tariff that you vote out we look at to see how we can use it to finance what we need to do. So I think it really emphasizes that, you know, we need to have the support of market rules in order to have these developed so they play -- at least at some level to play the reliability role.

Mark Lauby, thank you for using the term "metamorphosis." I'm going to use that in my speeches now instead of transformation, because I think it's more accurate in terms of the time it's taking.

Lorraine, thank you for explaining what's going on in Hawaii, which I think we could all stand to learn from. I just want to say that on my travels around the

country, I've had at least four or five different states tell me that they had the most aggressive renewable goal or the most aggressive efficiency goal or the most aggressive storage goal or something, and I said yeah, not unless it's 100 percent, because Hawaii is still a state. And it's really quite amazing what you've done.

My question, I mean, bearing in mind that we need to be mindful of all parts of our work, economic regulation, the market regulation and so forth, I do want to focus in on standards.

And so my question, particularly to Mark and Allen, but to anyone is, with all of this metamorphosis about the resource mix, are there -- looking ahead are there changes in the standard and the fleet of standards that we should be looking toward, either beefing up essential reliability standards, beefing up planning standards so they include some fuel visibility, which is not in the planning standards now, it's just N minus 1, or anything else?

Should something be on our medium turn horizon in order to make sure the standards adapt to all these changes?

MR. LAUBY: Well, I'll start that off with remember, of course, the TPL standards do call on extreme case for pipeline construction, so it does have a concept

to it. But that being said, I mean, you know, storage is not called out, right, for example, and that's something certainly we should be considering and we're actually evaluating ourselves, working with Argonne National Labs or some of the additional facilities like Aliso Canyon out there or single-point failures.

So what we are doing, of course, from the gas perspective is calling on industry with the TPL standards to be planning for the risks themselves. I mentioned before some of the protocols that we defined in a recently released report, you know, having a corrective action plan or an action plan that results from studying the different types of disruptions, you know, clearly come out of the standards and are something that are evaluated. And perhaps we need to look at that a little bit more once we have a better understanding of some of these other single points of failure.

With regards to distribution, distribution energy and distributed energy, there is a task force that's actually underneath the essential reliability task force studying this very area, what kind of information flow is needed, you know, between distribution systems and the bulk system so that they can manage reliability.

And so once that kind of starts getting more information from those groups, and you know how active

they've been, like the essential reliability services, in about a year we're going to get a white paper at the end of this year and then a -- next year a final report, along with the essential reliability services task force coming out with different type of quantities of sufficiency around some of these essential reliability services, I think we will have a little bit more to work with.

MR. MOSHER: And the subject of standards generally, starting with variable energy resources and the need for essential reliability services, that was one of my opening points, is that I think we have time to do the studies and figure out what we need first before we launch standards projects.

And frankly, we need to do a bit more modeling here and a bit more assessment of the underlying problem. And DERs at the distribution level, regardless whether they're customer or utility-owned, that really falls in the same category, that's it's too soon for FERC to be thinking about requiring NERC to do standards.

You should be, of course, supporting various jurisdictional utilities such as the California ISO or PJM when they need to make filings to address current market problems.

But I'm really asking for a bit of space, particularly on distribution, for distribution utilities to

work things out here. We have real customer safety issues -- or customer safety and utility worker safety issues here in terms of interconnection of distributed energy resources. We've got IEEE standards and other work going on that, I think, will inform what the Commission wants to do. So that needs to take place first.

Downstream, yeah, you may be setting specific requirements, but you may want to do it through tariff mechanisms rather than through reliability standards, frankly, there's some options here.

COMMISSIONER LA FLEUR: As we have looked at with frequency response.

MR. MOSHER: Yeah, as you are.

COMMISSIONER LA FLEUR: Well, thank you very much for that. I mean, I think it's a matter of gauging when it's -- when the state of play is mature enough to act and I'll just mention that in, I think it was, 2013 when we first kicked off gas electric, I think I sent out five questions that -- remember when we sent out the questions before they opened the docket. And one of them was, should we be looking at reliability standards. And the answer I got resoundingly from everyone is no, hell, no, don't do that. But a lot of water has gone over the bridge since then, with the polar vortex and Aliso Canyon and so forth, and I just think we have to keep an open mind.

Thank you.

CHAIRMAN BAY: Thank you, Cheryl.

Tony?

COMMISSIONER CLARK: Thanks, everyone, for being here and for a very good panel.

Whenever I hear discussions about things like microgrids and some cutting-edge technologies and things like that, I'm always reminded of a -- something that someone said, and I can't remember who it was, but it was early on in my days as a commissioner, and it always stuck with me. The comment was oftentimes a question isn't can you do something, the question is as compared to what and at what cost.

And so, Commissioner Akiba, I'm curious how you dealt with that issue in Hawaii? I understand it's a different regulatory regime and a lot of what we deal with and some of the interconnections in the mainland --

HAWAII COMMISSIONER AKIBA: We don't have FERC jurisdiction. There is no NERC jurisdiction. We don't have regional transmission authorities. We don't have -- in one case, we have a fully -- oh, I'm sorry. So we have a very different situation than the rest of the mainland.

But the electrons are electrons, the grid is the grid, and therefore, the solutions really are to find the cost-effective way of mitigation measures. And it really

is rethinking the stability requirements.

And I would really direct the Commission to the GEHNEI study because that was a very thorough modeling. That was done with help from the National Renewable Energy Lab, NREL, and I think it's a good study in that it really -- you have to rethink the traditional way of balancing all these interests and looking at more -- and I think some of the speakers this morning addressed that, maybe more risk-based, and also really how do you utilize the renewable resources in a cost-effective way.

And we're finding that the market does respond. The market has responded on some of our island grids with very innovative solutions to pair renewables with energy storage, to use control technology, to use renewables for load shifting, not just to reduce peak but to really shift load and to use storage to dispatch renewables, solar at night, wind at another time of the day when -- in order to balance the portfolio and keep the system in balance.

And the technology is there. So there's a lot more distribution technology that's being integrated into grid operations at the transmission or the system level.

And I think, you know, although my California PUC colleagues from NARUC aren't here, I have to give them credit for really tasking the utilities to plan at the distribution level so that when they interface with Cal

ISO, there's a better information, better resource management to be able to bid into that market. And when Cal ISO looks at what is the demand response or DER aggregation that's being bid into that market they can feel comfortable, that really -- that's based on real data, that's based on real performing assets that will deliver when you call upon it.

We tried to do that in our own small jurisdiction with -- I didn't go into details about the orders, but there's a DGIP, a distributed generation resource integrated portfolio plan that we required our utilities to do in addition to more of the bulk power planning, which was the power supply improvement plan, plus, we also required them to do demand response integrated response.

So they've got a plan at all these levels because all these pieces factor into that coordinated balance. And it isn't easy. It's a much more complex system. But that's why we have to rethink the traditional methods of evaluating reliability stability. And it's still very important. We have to be able to rely on the lights being there and also resiliency is -- you know, one of the main customers in Hawaii is the Department of Defense.

So resiliency and security, energy security is

utmost. And that's true for many of our customers on our grid. So you know, it's a similar concern. But that's how we do it. I think you have to have regulatory structures at the distribution level that help to facilitate the information into the transmission level.

UTAH COMMISSIONER CLARK: Yeah, it seems as though there's -- with the Hawaiian example, there's a lot that can be learned generally from the engineering aspects of the grid, that can be applied pretty much anywhere. And then I think there's some things that probably can be applied to a greater or lesser degree in certain jurisdictions where you have a little bit more of command and control from a state perspective. You have vertical integrated utilities, California is good example, where certain things are just baked into the cake.

I think from a FERC perspective, where it gets more and more challenging is when you get into restructured parts of the country. And there it's closing market signals that are determining where investments get made. And if low-cost natural gas -- to the degree you have a national energy policy, it's what is low cost right now, and right now, natural gas is low cost.

And so it seems like our tools are just a little bit, probably less attuned to taking some of those things into consideration. But I think you're absolutely right.

HAWAII COMMISSIONER AKIBA: But -- well, in Texas, which is, you know, a deregulated market, and the market does govern there, I mean, ERCOT I know, and then some of the others there, they're being actually at the very cutting edge in terms of some of these issues and trying to put distributed resources, also demand response, into the market and renewables.

COMMISSIONER CLARK: It's another nonFERC jurisdictional. Maybe we're the problem.

HAWAII COMMISSIONER AKIBA: And so these things are happening and in, perhaps, synergy, you know, with FERC, you know, seeing what's going on and being able to hopefully to adapt and -- you know, in terms of metamorphosis and continuous improvement, be able to adapt some of those structures for the retail markets that FERC oversees or for the bulk power markets. I think there are lessons to be learned and one size doesn't fit all. So even within your jurisdiction, I'm sure there's going to be tailoring that has to be done.

COMMISSIONER CLARK: This is sort of a general question to the panel, and whoever wants to take it up can. But I was curious about something that Allen said towards at the end of his presentation, which I've kind of been wondering about, too.

In the greater scheme of things, although we

talk a lot about things like microgrids -- and first, I'll step back. Telemetry and visibility into the grids, I mean, those issues are already here, right front and center. Microgrids are a little bit different. And I'm wondering -- I'd like to follow up on that question he posed, which is, are they kind of a niche thing that we spend a lot of time talking about, but really it's they're very applicable to certain economies, islanded campuses and true islands and things like that, or is this really the wave of the future, or is it a matter of large central generating stations are -- the economies of scale are so big as of today, that that's really the foreseeable future, is that sort of grid? And anybody can take it up who wants.

MR. MOSHER: I stated my mission to you, but I wanted to elaborate in a slightly different way. We're coming into a new set of customer options in terms of sort of total energy solutions and what consumers need. In my written comments, I alluded to the Defense Department having resiliency mission assurance issues. Server farms have 5-9s, 6-9s reliability, they can't have even a momentary blip. It might be acceptable to the Navy in terms of power supply -- okay, the answer is no. So you want all kinds of levels of resiliency. But customers at the residential level or industrials have changing needs,

and it's up to utilities to figure out how to do that.

My main point was that the integration of those customer-side resources into utility operation in a rather complicated customized way is where the real value is captured. Just as Princeton was looking to participation in wholesale markets as a part of the value stream, we see the same thing like in discussions about storage.

And storage by itself and energy only doesn't make any economic sense right now. It just isn't cheap enough. Maybe there's a combination of different value streams from a lot of different applications that make it make sense. Again, I'm talking about in the continental U.S. It would probably be different in Hawaii.

But that's the area that we want to go, and microgrids ought to be evaluated in that in terms of the value of being operated in isolation from the grid for a niche customer need.

MS. HENDRZAK: I would add -- this is Chantal. I would just -- I would build on to that in terms of, if you take energy storage or anything by itself, and if it's just looking from one particular lens, be it either at the retail level or at the distribution level or only at the wholesale level, you might get suboptimal results. You might not be able to reap all the benefits and the efficiencies and the benefits to everyone involved that

could be there if you do start to look at it together.

But it's complicated, and it's not easy, because you've got all these things that kind of push and pull against each other. So trying to help navigate through that complexity a bit and be able to have something like a microgrid or whatever, be able to look at the big picture and say well, maybe I could play in these different spaces, but then what do I need to do to be able to do that, then maybe they do show the value and the cost is worth it and the benefit and they do take off.

MR. SHAHIDEHPOUR: The statement I made earlier was based on the experience that we have microgrid, we have at the university. So 12-megawatt operation, we save the university about a million dollars a year. All the numbers are there, and they're documented.

And the primary reason we build a microgrid was reliability. I can tell you horror stories about days that we did not have microgrid and it cost us quite a bit, a research lab, a hospital, different facilities that we have. And when we lost energy, it was devastating. Ever since we have built this microgrid, the downtime has been zero because of the setup that we have.

And one thing that's critical is that from a utilities point of view, they don't see our operation as a microgrid. They see it as a controllable load. We are the

ones behind the meter that operated the microgrid. We work with the utility, and for reliability purposes, if they need to reduce load or manage the load, we work with the utility to implement that.

But as I said, in our case, it was reliability. In other parts of the country, like what the Commissioner pointed out, at Princeton, could be resilience, or it could be economics in California. So there are different reasons to build microgrid. They aren't all for the same reason. As I said, in our case, we have a proven case of about 52 buildings that we operate, and we do quite a bit of demand response. We charge and discharge storage and operate our power plant and all that, and it saves the university money.

MR. MURRAY: If I could retailor a couple questions and just give my real-world experience, recent real-world experience. I talked to a lot of the experts about microgrids, how you find them. There is no real good secret sauce yet that's been figured out. The controls are expensive. If you combine somehow cogeneration with your microgrid, you'll be able to make some money and maybe make it better. But depending upon what -- your goals and how you define the boundaries of it, the value proposition may just -- it may be out of the money. So you've got to figure that out.

When I went out to some state experts about the value proposition for a microgrid, I said we have a lot of land available for an outside person to come in and build some facilities, build some assets to help service your grid. Can you tell me if we're located near a hot spot, if generation in our area would be helpful for the local utility or some other person. The answer I got back was we don't know, we're looking at it. We do have a rulemaking to explore that.

So while on some respects FERC and others have done a lot of legwork on where we should plan for transmission lines, not a lot of planning has been figured out on where to do DERs for helping grid reliability in certain areas.

Now, when you think of it that way, you're going beyond the small campus-type microgrid concept to something a little bit broader, a regional-type concept of a microgrid. So it depends how you define it. But the value proposition is hard to get your head around, especially if you're like us, the Navy, trying to figure out how to get third parties to pay for this.

MR. ROTHLEDER: I think it may feel like a niche now, but I think as communities comes together and weigh the economics, reliability, resiliency and their choice of how their -- what supply serves their load, I think that

could quickly change. And I think that maybe the game changer on that could be the cost of storage. And if the cost of storage comes down to a level that makes a community potentially look economic to consider it, considering the other attributes, I think it could move away from just being a niche.

MR. LAUBY: Yeah, I liken it to the computing industry. I'll build on Mark's comments. Many of you are not old enough to remember big computers, like 360s and 1401s, but the huge monstrous computing machines, which now I still call my phone a machine because I'm aged. But now you have a phone, right, that has just as much computing power. Very much the cost kept coming down.

I remember meeting Dr. Shahidehpour back in the 1980s, I hate to say it's that long ago, when we started with the microgrid concepts, and now we've seen the costs and the prices of the technologies drop over time. And as my colleague Mark indicates, then the applications start increasing, and you start worrying about how can I apply energy in a different way.

And so I think over time we'll see more and more microgrids. This is my opinion. But that, you know, you're still going to need the bulk system. You still need the Internet. You still need large computing power to support different applications. So it will be kind of a

synergy between a bulk system that supports -- the nice thing about it is when the telecommunications systems went down, your phone didn't work for huge swaths. Now with your cell phone, you can still be making phone calls. You just go to the next cell; right? So again, more reliability in telecommunications.

Similarly, too, I think we'll have the bulk system to support microgrids, and providing frequency support, ramping, et cetera, but it'll be much -- it'll be a different system. We're looking 20, 30, 40 years out.

CHAIRMAN BAY: Thank you. Thank you, Tony.

Colette?

COMMISSIONER HONORABLE: Thank you, Mr. Chairman. This is a terrific panel. My one question, I think, actually was covered in that last round of discussion, but I want to pose it in the event that someone didn't get a chance to address it.

As I came in, Dr. Shahidehpour, you were addressing the fact that developing countries have done a better job of evolving in the development of microgrids than we have here in the U.S. And I wanted to put -- get a better feel for what we could do to improve that here in the U.S.

I think some of you have spoken to that. But if there are barriers -- I think Allen has something he wants

to add here. If there are barriers, particularly in regulation, I would be interested in hearing that, too.

And maybe I should yield back to Dr. Shahidehpour, if you don't mind.

MR. SHAHIDEHPOUR: The example I used earlier was between cell phone and landline. And I pointed out that in many other parts of the world people have completely abandoned the landline system because the system is so defunct in those parts of the world where fixing it was very costly. So when they started rebuilding the system, they used a new technology, which was wireless.

And it's the same thing with electricity. In many parts of the world, the existing hierarchy, go to like Asia or Africa, some parts of Europe, it's so old and outdated that fixing that is going to be very costly.

So rather than rebuilding this centralized large transmission system, they're going to distribute it. And in some parts of the world, trouble spots, building a massive infrastructure is out of the question.

First of all, they don't have money. Secondly, in those spots when there is a problem, a massive system is going to be taken down right away.

So going to distributed systems, especially like in villages in Africa, is a way of sort of moving forward. All of the work that we're doing currently in -- Ghana and

certain part of India points out the fact that this is going to be the way of the future.

So the existing transmission system in the United States is working. So here, people are still debating, decisionmakers are debating do we need distributed system, do we need microgrid, while the rest of the world is moving forward with this new technology that's being developed in the United States primarily because --

COMMISSIONER HONORABLE: We're still talking about --

MR. SHAHIDEHPOUR: Exactly, we're still debating where we want to go that way or this way. But one critical issue I should add on that point, that if you're going to develop this technology, microgrid technology, we should not sort of imbed it into the existing system. That's an issue.

I mean, a lot of times we discuss whether we need like microgrids or do we need to keep what we already have and all that. It's going to be the same thing with the landline versus wireless system. You have two different technology. You cannot build a wireless system on top of landline system. These are two different hierarchies, two different technologies, two different applications.

But I think the future -- the same way that the

future belonged to wireless system, all the work that you can do on the technology that you can build as a part of wireless telephone, I think it's going to belong to wireless system, distributed system, batteries and all that, and I think it's going to happen.

COMMISSIONER HONORABLE: Thank you. I think Commissioner Akiba said not either/or, maybe both.

Allen. And then Commissioner Honorable.

MR. MOSHER: You asked actually a very interesting question. I was just over at the Brookings Institution last week for a discussion on international development. People -- and they don't agree about whether to support distributed networks, small PV panels to supply small bits of power to Indian villages. One of the things they discussed was villages complaining that they're being sold bogus power. Why? Because it turns out it was just a bit of energy from solar panels. They didn't have enough power there to hook up the rice cookers that the people had in the village. So the answer was, they didn't meet the needs of the consumers that are there.

For the U.S. cases, I think microgrids, I still stay where I am, that I think it's a microcase for specific customer applications, but it does have real applications in the third world. Very often, though, the use of microgrids in the third world is a manifestation of the

lack of reliability of the central grid because they haven't built the infrastructure properly. And I lived in India and experienced that firsthand for a year. I can tell you many things over a beer.

COMMISSIONER HONORABLE: Thank you. I'm sure somebody's going to take you up on that.

Commissioner Akiba?

HAWAII COMMISSIONER AKIBA: As I said before, I think -- and I don't disagree with Allen that it is, you know, tailored to the particular jurisdiction, tailored to the particular customer needs. But in Hawaii -- and I hope I'm not giving away secrets for DoD, but all of the Department of Defense facilities, the major bases in Hawaii are microgrids already. We don't advertise that, but they are for energy security purposes. Some of them have gotten recognition recently because of the integration of renewables and other technologies in those microgrid systems and working with utilities.

But for island grid systems and for areas -- remote areas, currently -- we call them integrated energy districts. Microgrids -- for some reason psychologically it seems to be like a separate thing. Right now in the transition as we still continue to make this metamorphosis, as Commissioner LaFleur says, there are versions of microgrids, and they're integrated right now, and they

serve good purpose, and they're a part of providing load shifting. They're a part of doing all these different tasks. They might relieve transmission congestion. You know, FERC has that big responsibility. Or transmission on, you know, expenditures where you can do a nontransmission alternative to serve an area that has become a load growth area unexpectedly. So there might be some other economic policy reasons for an integrated energy district, as we like to call them.

But it is a balance I see now, at least in the foreseeable future, and they do serve purposes, especially for somewhere like our island systems where maybe part of the system may go down, but if you have islanding within islanding, the whole island doesn't go out, but you have pockets of -- natural disasters systems, or should we be the target of some geopolitical event, you have pockets where there will still be basic services, you know, critical services that can be delivered to the population in time of need. So I think there's variations on a theme here.

COMMISSIONER HONORABLE: Thank you.

One question for Chris Murray. It's great to have you back. I have one question for you. Don't feel like you need to answer it in this setting. When are you coming back? Okay. You don't have to answer.

MR. MURRAY: I'm here.

COMMISSIONER HONORABLE: We've learned a lot from Chris over the years.

I want to commend the Department of the Navy for your leadership and also for the way in which you are engaging with a number of energy stakeholders with whom you probably have not had the luxury to be engaged with over time. But we are learning from you, too, but I hope that we can support national security as you're going about ensuring reliability and resilience of your facilities, because I see the two as being hand in hand. I'm certainly no national security expert, but I imagine you need us to do what you do. So thank you.

MR. MURRAY: Thank you, Commissioner.

CHAIRMAN BAY: Any other questions?

COMMISSIONER CLARK: I just had a really quick follow-up question to Dr. Shahidehpour. I was curious about exploring your analogy in the telecom industry and wireless versus landline phones and distributed networks, microgrids, and the BES. Because I want to make sure I'm not misunderstanding what you said.

Are you suggesting that the grid of the future, as you have these different microgrids come about and so on and so forth, that it's a total separation from the sort of grid as we know it today, so complete substitution, or is

it, using again the telecom analogy, yes, you have wireless phones, and retail customers may be substituting their landline for their wireless line, but behind the scenes at the backhaul level there's lots of landline sort of infrastructure that's used to haul that telecommunications information around?

And I guess the analogy on the electric side would be okay, you've got more microgrids that are starting up and that are out there, but you still have aspects of the bulk electric system that they're connected to and that help balance the grid and have frequency attributes and things like that.

MR. SHAHIDEHPOUR: Well, the point I made was that there are many things that you can do with a wireless phone that you cannot do with a landline. So if you want to compare them and say we don't want the wireless system because a landline can do a similar thing, that's not going to be the case. There are some specific characteristics attributed to a wireless system that a landline system cannot do that. It's going to be the same thing with a large electrical system. You can implement certain types of control that you may not be able to do with a large system rightfully. So in the sense, in that respect, they are two different systems.

But one thing that's critical in this discussion

is that for you ladies and gentlemen at FERC, to figure out how microgrids can be implemented in the United States, to the point that utilities can survive. If everybody starts building microgrids, the question is, why do we need a centralized utility? The fact of the matter is that centralized utility is going to be the backbone of the system, is going to continue to exist. We need to learn how wireless technology and distributed system is going to work with the utilities to work as an integrated system, whether they're two different technologies.

The fact is, I operate a microgrid in Chicago at this time. I don't want to advertise it, but I'm using the utility in Chicago as a backup system in the sense that whenever I cannot supply my own load, I'm going to call on the utility to supply my energy. I don't think the utility can survive if everybody does that.

So for the regulators and for the decisionmakers in the United States, it is important to come up with a sort of managing the system so the utility can survive, along with distributed systems and microgrids.

COMMISSIONER CLARK: Thank you. That's very helpful.

CHAIRMAN BAY: Thank you, panelists.

Let's take a 10-minute break. We will resume at 3:10.

(Recess.)

CHAIRMAN BAY: Thank you, everybody.

Our last panel of the day will focus on grid security. I'm pleased to welcome our panelists here today.

One announcement, the speaker's comments have been posted on eLibrary, Docket AD16-15.

Let's go ahead and get started.

Deputy Assistant Secretary Streit?

MS. STREIT: Yes. I'm first up?

Good afternoon. I would like to thank you, Chairman Bay and your fellow Commissioners, for inviting me here today to speak to you and giving me the opportunity to participate on this panel.

My name is Devon Streit. I am the deputy assistant secretary for infrastructure security and energy restoration -- we call it ISER -- in the Office of Electricity Delivery and Energy Reliability at the Department of Energy. Try that three times fast.

ISER is responsible for filling the department's lead role for emergency support function 12, energy, and for coordinating the federal response and support to state and local efforts to address incidents affecting energy infrastructure, regardless of cause.

DOE is also the sector-specific agency for energy, and in that context, ISER represents the interests

of the energy sector in interagency fora and works to strengthen the preparedness and resilience of both the oil and natural gas and electricity subsectors.

I'd like to take my time with you now to quickly address some of the topics raised by you in the questions provided me in advance of this panel, including the strategies for increasing the resilience of the grid, FAST Act authorities, and the threat of electromagnetic pulses.

Previous incidents such as the one that occurred on April 16, 2013 against the Metcalf substation near San Jose, California, have confirmed that the power grid is, to a great extent, a robust ecosystem that can survive an unusual attack without experiencing widespread and extended power outages.

Nevertheless, emerging threats posed by new technological capabilities make energy infrastructure security a constantly evolving and increasing challenge. Regardless of the resilience of the nation's power grid, a sustained effort will be required to protect critical assets.

Simplifying or nondigitizing the technologies used at certain critical points or locations is not the answer. While digital technologies may create potential cyber vulnerabilities, they also enable many enhancements to the reliability of the grid operations. A

forward-looking approach is needed, one that favors the development of security features that are integrated into the design of components on the front end. Security must be built into the advances that make the grid smarter and more resilient.

One area of focus that can reduce the length -- excuse me, the risk of lengthy outages is improving the logistics related to the delivery of replacement equipment. Increasing the availability of key equipment spares, including transformers, which could be made readily available to replace damaged items, would help mitigate the effects of energy grid disruptions and shorten energy restoration timelines.

Additionally, a strategic transformer reserve as contemplated within the FAST Act could become a key tool for minimizing the impact of power grid disruptions. Both government and industry organizations are pursuing this general concept.

The FAST Act also gives DoE the authority in the context of a grid security emergency declared by the president to issue emergency orders to protect or restore the reliability of critical electric infrastructure or defense-related critical infrastructure during an emergency.

DoE currently is developing proposed rules of

procedure for expediting orders in the context of this emergency and will continue its partnership with the energy sector to maximize the effectiveness of this authority.

In addition, FAST Act codifies PPB 21 in identifying DOE as the sector-specific agency for cybersecurity events as they affect the energy sector. The department continues to evolve its cybersecurity role as the technology landscape changes, and with industry, we're working to build on existing programs, such as C2M2 and CRISP, to enable all stakeholders to improve their overall cybersecurity posture and mitigate the potential effects of a cyberattack.

With respect to the threat of EMP, we know that an electromagnetic pulse, if strong enough, can disrupt or damage electrical equipment, including critical computers and communications equipment that allow for smart operation of the energy grid.

In partnership with EPRI and the ESCC, DoE is developing an EMP strategy and an action plan to be released later this year. We are also working with DHS and funding a new project with Los Alamos National Laboratory to identify EMP attack scenarios that are of most concern to the energy sector. However, more scientific testing will be needed to determine the vulnerability of all equipment and components associated with power plants and

substations to different levels of EMP effects.

With that, I want to thank you for my time and I look forward to answering any questions you may have as the conference progresses. Thank you.

CHAIRMAN BAY: Thank you, Deputy Assistant Secretary Streit.

Ms. Dodson?

MS. DODSON: Good afternoon, Chairman Bay, Commissioners LaFleur, Clark, and Honorable, and fellow panelists. Thank you for the opportunity to join you today and speak about security and resilience of the electric grid. My name is Donna Dodson. I am the chief cybersecurity adviser for the National Institute of Standards and Technology. I'm also the associate director for cybersecurity within our information technology laboratory.

NIST is a nonregulatory federal agency within the U.S. Department of Commerce, specifically focused on promoting U.S. economic competitiveness. The NIST laboratories work at the frontiers of measurement science to ensure that the U.S. system of measurements is firmly grounded on sound scientific and technical principles.

Today, the NIST laboratories address increasingly complex measurement challenges, ranging from the very small nanoscale devices to the very large vehicle

and building, from physical, renewable energy sources to the virtual, cybersecurity and cloud computing.

As new technologies develop and evolve, NIST measurement research and services remain central to innovation, productivity, trade, and public safety. A major component of NIST is our technology laboratory. In our ITL we develop tests, test methods, proof of concept implementations, and technical analysis to advance the development and productivity and use of information technology, including in cybersecurity.

Today, I want to focus my comments on NIST research, development, and outreach to provide standards, guidelines, mechanisms, tools, metrics, and effective application of these resources to protect the U.S. information -- and information systems and industrial control systems.

To address some of the questions, I want to first talk about cyberthreat information and sharing of that information. So cyberthreat information is any information that can help an organization identify, assess, monitor, and respond to cyberthreats. Examples of cyberthreat information include indicators, such as system artifacts, or observables associated with an attack, security alerts, threat intelligence reports, and recommended security configurations.

In April of 2016, NIST released the second draft of Special Publication 800-150, Guide to Cyberthreat Information Sharing, for public comment. The draft provides guidelines for establishing, participating in, and maintaining cyberthreat information-sharing relationships. The goal of the publication is to provide guidelines that help to improve cybersecurity operations and risk management activities through the safe and effective information-sharing practices.

The threat to our systems and information is dynamic and rapidly evolving. We must build equally agile and responsive capabilities. NIST has developed standards and guidelines and recommendations to provide a standardized and repeatable framework, the risk management framework for managing risks to federal information and IT systems. The risk management framework provides a structured yet flexible approach for manning the risk -- managing the risk resulting from using information systems to achieve the business and business processes of organizations.

In addition, NIST works closely with international -- national and international standards bodies. Recently, in February 2014, NIST issued the framework for improving critical infrastructure cybersecurity, known as the framework, under Executive

Order 13.636.

We have also worked closely in our communications technology laboratory to conduct research to develop measurement methods, interference models, and metrics to improve electromagnetic compatibility, EMC testing for communications and other systems deployed in smart grid environments, and to provide technical input into smart grid EMC standards activities to meet performance and interoperability requirements. This work has transitioned over to industry, and we are very excited when our work moves in from theory into practice, as we've seen with our EMC standards and our risk management framework.

And with that, I'm over time. So thank you for the opportunity to speak with you today, and I will be happy to answer any questions you may have.

CHAIRMAN BAY: Thank you, Ms. Dodson.

Mr. Ford?

MR. FORD: Thank you. Chairman Bay, Commissioners, fellow panelists, I appreciate the opportunity to participate in this technical conference on behalf of NRECA and Georgia System Operations.

I've chosen to focus on three topics where I believe I can offer a different perspective. Those are the lessons that should be taken from the Ukraine attack, the

need to maintain our manual operations capabilities, and the frequency of violation of the PRC and CIP standards.

With respect to the recent attack on the electric infrastructure in the Ukraine, one lesson that we should take is that our efforts associated with the NERC standards to this point have been well-directed. Because of the work of FERC, NERC, and the electric sector, effective mitigation measures are already in place to protect the BES from cyberattacks.

For this reason, the Ukraine event should not be used as a justification for major changes in our approach to ensuring that reliability. The event actually provides some compelling evidence that our current approach effectively protects our control systems.

Following are some examples of how current measures protect us from the exploits of the Ukraine attack. A key element of the Ukraine attack was the ability to gain remote access to the control systems by stealing passwords. The CIP 005 requirement for network segmentation in the utilization of an intermediate system, along with two-factor authentication for remote access, is highly effective approach in developing this type of attack.

Additionally, malware detection and system hardening measures required by CIP 007 mitigate the risk

for malware reduction such as KillDisk or BlackEnergy. Monitoring and alerting requirements in CIP 007 also aid in detecting such attacks during the reconnaissance phase.

By implementing the required incident response processes included in CIP 008, malicious plans could have been diverted.

But to say that we have responded appropriately is not to say that there's nothing more that can be done. Protecting the reliability of our operations requires continued diligence in new threats and prompt and effective responses to those threats that are identified.

When examining these issues, reliability standards should not be viewed as the sole or even primary avenue of response. The industry is highly motivated to secure the assets critical to its core business and can and will respond quickly to information made available through the new threats.

Improved information sharing is, in most cases, more effective than new standards. Before standards could be developed, many entities began developing mitigation strategies to address recently discovered vulnerability issues.

Had an effective ISAC existed in Ukraine, impacts from the December attack may have been prevented as utilities enhanced their situational awareness based on

information shared by their neighbors.

In the U.S. the E-ISAC has been an effective tool for dissemination of security information to the electric sector. As the FAST Act and the CISA 2015 Act are implemented, we should be careful to ensure that the role of the E-ISAC is preserved and strengthened. We need to add to the abilities of our current tools to share information and not muddy the waters by creating a new mechanisms that overlap the responsibilities.

With respect to suggestions that we reduce risk by nondigitizing operations at current -- at critical locations, the advantages of enhancing technology have been well-demonstrated.

By utilizing technology, we have substantially improved the speed at which transmission operator can understand, analyze, and respond to the bulk system events.

Reverting back to manual operation methods can be done, but it will delay restoration from outages. The CIP standards provides substantial protections for these systems. I believe we need to continue to improve the security of our technology as opposed to abandoning it.

But with that said, I do believe it is critical that we retain the ability to operate in a manual mode as a fail-safe against worst-case cyber scenarios. This will require not only ensuring that the design of new equipment

continues to incorporate provisions for manual operations, but also that we continue to train our staff to operate in this manner.

It is easy to become on overly dependent on technology, and technology makes our operations more efficient and the BES more reliable, but we must continue to maintain our ability to operate without it.

Finally, I would like to address the frequency of violations of the CIP and PRC standards. One factor driving violations of these standards is their complexity. Prior to recent revisions, portions of these standards have been based on zero tolerance of activities that take place hundreds or even thousands of times. It is reasonable to expect more compliance exceptions from this type of standard as compared to other traditional reliability standards.

Recent revisions to these standards provide more flexibility in their implementation and should lead to reduction in violations while continuing to ensure the reliability of the bulk electric system. Another driver for the increased frequency of violations is the traditional reliability standards, predominantly codified, already in place practices, within our operations environment. Whereas, some CIP standards seek to significantly change the way the companies operate. The

frequency of violations is going to be higher for a standard that requires change from the previous practice.

To illustrate the changes being driven by the CIP standards, I would like to focus on patch management for a minute. It is well understood the implementation of security patches is critical to ensuring the reliable operations of technology that supports the bulk electric system. What is less understood to those outside the industry is that the implementation of security patches is also a significant threat to the availability of those systems. Every change made has the potential to introduce instability and create an unexpected downtime. While the shift to more frequent patching is appropriate, it must be accomplished in a way that mitigates the increased risk of instability caused by these frequent changes.

This is a significant modification to our operations, which is not practical to achieve with zero defects during the transition period. Industry is painfully aware of these violations and have been working diligently to address them.

CIP version 5 and 6 standards clarify these requirements, and the industry has improved its processes and gained valuable experience under the previous CIP versions. These factors should lead to reduced violations of these standards.

In closing, I would like to restate my appreciation for the opportunity to speak before you today, and I look forward to any questions.

Thank you, Commissioner.

CHAIRMAN BAY: Thank you, Mr. Ford.

Mr. Sachs?

MR. SACHS: Thank you, Chairman Bay, commissioners, Staff, fellow panelists.

My name is Mark Sachs. I'm senior vice president and chief security officer at the North American Electric Reliability Corporation, also known at NERC. I really appreciate the opportunity to participate in today's reliability technical conference. Grid security is a constant and ever-evolving threat that requires perpetual vigilance. In the interest of time, I'm going to summarize my written testimony with oral comments.

As NERC's chief security I'm the senior officer of the Electricity Information Sharing and Analysis Center, also known as the E-ISAC.

And thank you for your compliments, Greg. Greatly appreciated.

The E-ISAC is a leading source for voluntary information sharing for many in the electricity sector. It gathers information from electricity industry participants across North America about security-related events,

disturbances, and off-normal occurrences within the electricity sector. We then share that information with other electricity industry participants, key government entities, and cross-sector partners.

Government entities and partners also provide the ISAC with information regarding risks, threats, warnings, and other items that the ISAC disseminates throughout the sector. Two-way information-sharing is critical because it allows the ISAC to help industry identify emerging trends and to provide the early warning, particularly in today's ever-changing security environment.

Protecting critical infrastructure from cyber and physical threats and vulnerabilities requires diverse defense strategies. NERC's mandatory critical infrastructure protection, or CIP, standards are but one piece of a complex, dynamic, and comprehensive approach to grid security and reliability.

The public/private partnership that NERC has through the Electricity Subsector Coordinating Council, or the ESC -- which addresses resiliency and reliability issues, has greatly improved the conversation among government, industry, and with NERC. The Department of Energy is also a key partner with NERC in addressing, identifying, and analyzing security needs of the grid. These efforts are complemented by research and technology

development by DOE's national labs.

This work has significantly helped promote computer-to-computer monitoring and information exchange. And of course, our ISAC is an essential information-sharing hub that provides situational awareness, instant management, coordination and communication capabilities within the sector through timely, reliable, and secure information exchange.

We have a variety of tools inside the ISAC. We use the Grid Security Conference, which happens annually, to share information among industry experts and others. We have a portal. It's 24-by-7 Internet portable with a front page that's public and a log-in page that provides information to thousands of members across the United States, Canada, and portions of Mexico. We are building that portal out, and we plan to include international partners and other partners as well as we continue to enhance the information sharing.

We also run a grid security exercise, a GridEx, every other year, generally in the fall. The one we had last fall in November, very successful exercise, included over 4,000 registered participants, 360-plus organizations across North America. We also had a closed tabletop exercise with 30 industry and government senior leaders participating.

Finally, as was mentioned a moment ago, we have the CRISP program, or the Cybersecurity Risk Information Sharing Program. It's a voluntary program NERC runs along with DOE and the Pacific Northwest National Lab that enables owners and operators to better protect their networks from sophisticated cyberthreats. The purpose of CRISP, and we are fairly unique in this, in our sector, is to facilitate the timely sharing of government-enhanced threat information, enhance our situational awareness, and better protect our critical infrastructures.

We mentioned Ukraine a moment ago. Let me just kind of give you our take on Ukraine a little bit. It's an excellent lessons learned opportunity for all of us. As we remember, back in December, there were three distribution utilities in Ukraine that were attacked via a cyber intrusion. Breaking into those company's supervisory control and data acquisition systems affected about a quarter million customers over these distribution territories for several hours. Of course, this is the day before Christmas Eve, so a very important time there.

The events in Ukraine are a reminder that cyberthreats are real and that a constant vigilance is needed to protect the reliability of not only the European grid but also our grid and all other grid systems against this type of growing threat.

At the same time, it's important to note that the operational and technical aspects of the North American bulk power system were different from those that are used in the Ukraine. Some differences include the U.S. industry's mandatory and enforceable cybersecurity standards, also the controls that we have authorize personnel, training controls, network segmentation, and the use of licensed antivirus software, among many other things.

Following those attacks, the ISAC, along with some other partners, developed a joint report which was made publicly available. In fact, it's been downloaded thousands of times across the world. We watched Ukraine itself download our report. We watched the Chinese download our report, the Russians download our report. So lots of interest in that analysis.

It provides basic defense lessons. It provides cybersecurity tools and practices. And it's been well-received, and we'll continue to update and provide more information as it becomes available.

NERC also issued a Level 2 alert. This required companies to acknowledge the alert and respond back. We've provided the analytics of that information back to FERC. But of utmost importance, we've learned from this experience that the sector here, the North American

electric sector, is moving in the right direction with appropriate protections, including the mandatory CIP standards, advanced technologies, partnerships with industry and government, and information sharing in a rapid, increasing speed across the sector.

So in conclusion, to keep up with the changing threat landscape and to enhance grid security across North America, we have to remain dynamic and nimble. The ISAC understands this and continues to increase and improve its products and services to members and partners. We continue to encourage and facilitate greater information sharing, improve our tools, engage in exercises, and share the lessons learned. We're encouraged by newly enacted authorities to facilitate information sharing and strengthen the security of the bulk power system.

I appreciate the opportunity to discuss these security challenges with the Commission, and I look forward to your questions.

CHAIRMAN BAY: Thank you, Mr. Sachs.

Dr. Scaglione?

MS. SCAGLIONE: One of the key issues with cybersecurity is the inherent complexity of the task. We know mathematically some of these problems are actually intractable, if not undesirable. So there is no silver bullet. But information and visibility of the system is

pivotal, and I would say the system today hasn't leveraged information, precisely for the issue of securing from cyberattacks. And because information allows detect and adapt to the inevitable shortcomings of the cyber critical infrastructure.

Now, there are good examples of how this is changing. A good example is, for instance, the deployment of phaser measurement unit in large number -- in the transmission within the United States. We are already seeing the benefits in general for reliability, but also understanding right now the potential in cyber physical security.

The emphasis on modeling is certainly important, and I will go back to this point later. But models are never perfect, and this is why we need data. So learning algorithms that are based on real data cannot truly be completely replaced by models. Also because not only there is difficulty modeling accurately the system, but sometimes it's really painful to get the models right. So I wish also to remark that most of these experts are still top-down, mostly concerned with the transmission grid. But there are emerging technologies that will need a lot of -- more information in the field.

But with increasing penetration in fact of solar PVs and the potential electrification of the transportation

system, not to mention an aging distribution infrastructure, there is a need and an opportunity to explore a third way, which is to encourage the placement of intelligence and sensors at the distribution level. What I mean is not expanding on improving the advancement in infrastructure, but rather influencing directly what happens behind the meter. We mentioned the case of microgrids previously, and also sensing pervasively the distribution grid.

Perhaps the main metamorphosis should be at a distribution level, and perhaps the transmission grid should change less. And the regulation should ensure, in fact, that the transmission operations do not get in the way.

I would like to point out an important aspect about the power infrastructure that is not commonly recognized by comparing it with other infrastructures. In transportation metrics, we have flow control, but we manage congestion primarily because we rely on drivers decisions.

And it is possible because there is feedback to the users, the experience, latency, accidents, they know there is bad weather. Communication matrix such as the Internet, cellular, Wireless Local Area Networks.

Human beings are not involved in the resource allocation. The access is regulated by protocols, and

millions of points are controlled -- locally, and congestion is contained and causes gradual degradation thanks to -- but there is feedback to the users, and users experience -- latency or lack of service.

This is not true for power systems. First of all, the resource allocation is centralized at a certain time state and level, about 100 megawatts. The local control -- in a myopic fashion. But there is really no feedback to the users until we have a blackout, and the size of these blackouts is typically very large. So this is why I think placing emphasis on the distribution grid is really important for securing the system.

Now, we all recognize the surplus which is generated by the activity, comes from its ease of use, the fact that we use appliances that are plug and play, and that overall the system is relatively reliable and cheap. And given the size and complexity of the grid is quite reliable and is a relative success.

So the different stakeholders don't want to invest in improvements for which they're not able to see great benefits. They often do not understand that unlike weather events, cyberattacks come with no prior warning, although sensors in place could pick up anomalies and anticipate future effects of an attack. But they, of course, have a cost.

We are facing, however, an exciting transition. Industrial networked control is getting cheaper and even personal, not only being deployed by utilities of medium voltages but is also entering our homes for our personal convenience, not necessarily to help the grid. Many see this as an expansion of the attack surface, but that brings about the opportunity of having many more responsive points that can be used to mitigate problems and going beyond the plug and play model without intelligence, which unfortunately is strongly favoring the fossil fuel generation. And these would move forward, the integration of intermittent renewables.

So digitizing the system and managing access to the grid could allow the same graceful degradation that we experienced, for instance, in the communication network, face daily congestions and emergencies alike, while maintaining the same ease of use for the public.

So in my opinion, we should embrace innovation, not give in to the argument that less information is more security or that we gain security by obscurity. We did not continue to use horses because cars could cause lethal accidents. I think just closing our sites to innovation is not the right answer.

In addition, digital systems become unnecessarily complicated, and vulnerable often, because

they're poorly designed. We also have to recognize that we have made strides in the last 10 years, especially in terms of regulation, research, and awareness, if not obligations in the field. And we are continuing to learn. The Ukraine power attack was mentioned earlier. The Stuxnet malware. The Maroochu, Water Station wireless jamming attack. They all confirm something which is now a well-accepted principle, that securing the communication perimeter is of paramount importance as well as -- and other aspects.

The good news is there is evidence also that the Ukraine event in particular could have been avoided by complying to some U.S. standards, in particular the NERC CIP standard. The bad news is these standards are not often enforced. They are often violated -- other than direct experience, there is still a gap in guessing what could happen, and that's a gap in the research side.

As Professor Ilic mentioned previously, from the research side studying and modeling, cyber physical attacks scenarios is still extremely difficult. I really commend her efforts in trying to bridge this gap. It requires simulating and analyzing jointly the gap in between information networks, power networks, and controllers, and this requires, you know, a lot of different knowledge to come together.

While in the computer networks field simulations

on synthetic systems are well-established practice for testing the limits and to verify mitigation strategies in cases of failure, for power systems those that do not have privileged or costly access to data rely on more test cases drawing the real power systems and the functionalities of the many controllers in the field. Their functionalities also often obscured because of profitability standards that dominate the control industry, while communication metrics, typically standards are open so they're easy to simulate.

Going back to the point made about information sharing at this point in the prior panel, the Cybersecurity Information Sharing Act of 2015 and the Fixing American Surface Transportation Act are steps in the right direction. But regulations also need to be compatible with the economic forces that are competing with compliance and cooperation objectives, adopting systems probably of carrots as well as sticks. Perhaps what would help is to make also make it easy to share information. What may delay in fact information sharing is addressing the question of how that should happen, not only from setting up roots but also looking at the nuts and bolts of how digital information can be exchanged and queried in a secure manner, helping to remove engineering barriers as rules are set. One wants to avoid at all costs these burdensome auditing processes that absorb precious

resources and can stifle useful innovation.

From my perspective, it is really apparent on the other hand that we need to find a way to share data, not only for operational purposes but also for research purposes. It allows realistic simulations, as I was mentioning before, and in some cases, the emulation of what would go on during a cyber physical attack, without necessarily disclosing the true information about the system, yet giving information that can reproduce behaviors and trends that can be troublesome.

As I mentioned, test cases for research dwarf the system available at such a level it remains questionable how techniques would perform in the field. Now, this is in principle an easier problem than sharing information that has operational use, because this information could be analyzed, and while this would not solve the problem of immediate threats, it would allow us potentially to gain precious understanding of other problems that may yet arise in the field.

There is significant research currently, for instance, in anonymizing medical records or marketing information. And some of this idea have been applied also to anonymizing smart meter data, but they're not directly applicable to modeling systems. So how would you anonymize information that has modeling systems is still an open

question.

Also, I wish to add that there is a significant barrier to entry for non-power-system engineering experts to use the available tools and combine them with cyber simulations. Another level of complexity modeling -- is that we do not really present in other metric infrastructure, is the fact that there is a mixture of reliability engineering and economics that are at play that define the control and operation framework for -- and that will be very difficult to simulate.

So in spite of the fact that a lot of the innovations in the sector comes by the integration of embedded intelligence networking, there is still a gap to breach between communities that work at these two different sides of the technology.

I have to commend in particular DOE efforts, ARPA-e efforts, sponsoring interdisciplinary research in academia and National Labs that is really trying to overcome these barriers.

The other big question that was posed is how can we deal with evolving reliability issues. Particularly in the -- sectors, the -- cycle of innovation is very short, three years, often new standards emerge. So how can we deal with that? So setting up very broad guidelines is useful, but in general, complex regulation can stifle

innovation. So this is a real challenge in incorporating new technologies.

So the standardization process should start at the engineering level because the engineering and the physics really clarifies what is possible. And the creativity of the engineers really should be driven by the desire of innovating. But I see two aspects that could change in the sector.

First of all, I believe that great benefit could come by doing almost away with the idea of the closed proprietary control standards and technologies. So each, suppliers of controllers, vendors, software, network engineers and customers, could sit at common tables and promote common open standards that have the compatibility, the interoperability, the maintenance of such standards, while innovating the field. There would be provable benefits. And I actually draw an analogy with the networking field where oftentimes these standards are open and interoperable.

Once again, this seems counter to the idea that we have about security. We tend to think that security is obtained by obscurity, but in fact, it's important to share the collective burden of understanding what makes a particular technical solution reasonable, and opening these technologies is also the best way of debugging them and

facilitating their deployment and maintenance.

I believe this process would also facilitate addressing other issues, like creating technology that is proven to mitigate, for instance, electromagnetic pulses or other threats that are recognized as possible threats in the field.

We should also consider encouraging innovative standards that facilitate replacement of old systems, and they are in fact compatible with infrastructure. However, this would not be sufficient for this sector.

So the second possible way to address the evolving reliability issues is to invert the approach, and perhaps, rather than overregulating, be more open to set up a process to evaluate such standards, a little bit like the FDA evaluates new drugs. Right? So there is a huge risk also in the medical sector, but one doesn't want to stifle innovation. So instead of setting up the rules of what should be the right drugs -- maybe the industry could invent new drugs and test them very thoroughly.

So these could involve an institution potentially like NIST, for instance, or NERC or FERC, and that would require obviously broad expectations which could be included for specific technologies, targeted for specific technologies.

So ARPA-e and DOE in particular have emphasized

in their research programs significantly the need of transitioning research into technology, but they could also potentially emphasize the creation of these open standards and can streamline these processes of monitoring and approval.

So I -- and I also believe that these will also set up preferential pathways for standards that are emerging to solve really important, urgent problems. In other words, if you set up a process that can be essentially going in a fast track for technologies that are immediately necessary and collectively ensure that the industry is interested in developing these technologies, I think these could create a virtuous cycle that would improve the situation of the security.

With that, I conclude my statement. Thank you.

CHAIRMAN BAY: Thank you, Dr. Scaglione.

Mr. Stockton?

MR. STOCKTON: Thank you, Mr. Chairman, for inviting me to speak with you today.

I am the managing director of Sonecon, LLC. Prior to that, I was the assistant secretary of defense for homeland defense. I want to thank all commissioners and Staff for your contributions to natural security. The Department of Defense is utterly dependent on the flow of electricity to critical defense installations. I want to

thank you and all at FERC for helping facilitate the resilience and reliability of that electricity.

My prepared statement focuses on a key challenge in the cyber realm, which is how to build the equivalent of a cyber mutual assistant system that we got to enjoy in Sandy where the ability of tens of thousands of utility workers to flow from across the nature greatly accelerated the restoration of power. We need some functional equivalent in the cyber realm. It's a big challenge.

The Electric Subsector Coordinating Committee is making some progress, very significant progress. I would be happy to talk about that in my Q&A period.

But with the very few minutes I have, I want to do two different things. I want to talk to you about a challenge that I don't think is getting adequate attention.

And then secondly, I want to give you some kudos for work that you're doing that I don't think is getting sufficient recognition. I would ask that you move it forward.

On the prong that needs more attention, I would like to focus on the cross-sector interdependencies between communications and the electric subsector. The problems here are pretty well understood in a traditional framework. If the grid goes down, communication systems begin to degrade, and the electric subsector requires our

communications in order to conduct power restoration operations. That's pretty well-understood.

And I look at it really as a function of cascading failure. The grid goes out. Therefore, communication sector is degraded. Therefore, power restoration is slowed. We are missing something important.

Thanks to those that attacked the Ukrainian power grid for wising us up to something that we need to be prepared for, and that is a simultaneous attack both on a communication sector and the bulk electric system. Our adversaries may not do us the favor, may not do us the kindness, of attacking one sector. They may hope to achieve synergistic effects by attacking both sectors simultaneously.

I'll give you an example. If power goes out and that begins to degrade communications systems, a lot of communications systems on which power restoration will depend, components have pretty robust emergency power capabilities. They have generators, merchant generators, diesel fuel stored on-site, decent plans for resupply of those fuel stocks. So you'll have a gradual degradation of communications capabilities. Electric power companies can gradually spin up their emergency communications and deal with the challenge over time.

A simultaneous attack on communications,

potentially against ground systems for satellite phones, a targeted attack designed to magnify the effects of loss of communications for the power industry, that is a problem that needs much more attention.

But even more significant than the severity of the problem, I think we need to think about the coordination mechanisms that ought to exist for prioritized restoration of service to critical communications facilities and functions. I'm not sure that we have the cross-ISAC communications capabilities that are resident within the electric subsector with something like CRISP, which I greatly admire. What are we going to do to provide for cross-sector information sharing when these two sectors are so inextricably linked in terms of recovery of service?

And then finally, how do CEOs talk to each other across sectors in order to provide a prioritized effort, in order to make sure that the assets are being allocated in a way that's commonly done within the electric subsector? Across sectors is much more difficult.

I promised to give you some kudos. I'm so grateful for the attention that you're paying now to interdependencies between the ONG, oil and natural gas subsector and the electric subsector. It's extremely important. Thank you for your recent reports. It's just terrific work.

I'd ask you to continue to focus on the challenges of the resilience of black start capabilities. I'm not talking about the black start units themselves. I'm talking about the increasing reliance many of the DES companies on natural gas as a source of fuel for their generators on their cranking path. This, my friends, deserves careful attention. I look forward to discussing those challenges during the question-and-answer period.

Thank you again, Mr. Chairman, for inviting me to speak.

CHAIRMAN BAY: Thank you, Mr. Stockton.

Mr. Popik?

MR. POPIK: Thank you very much.

Again, my name is Thomas Popik. I'm chairman of the Foundation for Resilient Societies. I would like to thank the Commission very, very much for allowing me to come here and present a viewpoint which is divergent from many of the viewpoints that you've heard earlier today.

Commissioner LaFleur earlier asked where have we been and what have we accomplished in the last 10 years, and what do we need to accomplish now. And so I'll try and answer those two questions.

First, what has been accomplished? I think it's fair to say that in the last 10 years a baseline set of standards has been established by NERC and FERC. And

against this baseline set of standards, there is tracking of outages. And let's be very clear. There has been no major cascade since 2011, and that is a significant accomplishment. Now, going forward, what should be next for the 10 years going forward? I would say it's addressing high impact/low frequency events. And these are cyberattacks, physical attacks, solar storms or GMD, and what I would call intentional electromagnetic pulse, which could be both nuclear EMP as well as localized EMP.

Let's talk about these threats in the context of the North American grid. The North American grid is becoming increasingly fragile due to decisions that are societal. Not all the decisions are made at FERC or NERC or DOE, but they're societal decisions. NERC has done some excellent analysis in this regard, and one of their most recent reports is about the overreliance on natural gas.

That is really correct, but there's another part to it as well, and it's the overreliance on long distance transmission. My group has done analysis on a state-by-state basis, and these are political boundaries. I know they're not reliability control areas, but it's still very relevant. A state-by-state analysis of overdependence on natural gas that crosses a state boundary and electric energy that crosses a state boundary.

And I'm going to read you some statistics for

places like California that we've talked about previously today. For California, approximately 70 percent of the energy for electricity crosses the state line. So these supply lines are very long, very tenuous, and they cause a situation which is the opposite of resilience.

For Commissioner LaFleur, her home state is Massachusetts, and the comparable figure for Massachusetts is 80 percent. 80 percent of the energy for electricity crosses the state line.

And again, this is a result of societal decisions. The way electricity works in the United States is a lot of it is generated in the center of the country, and it's consumed on the coasts. Why? Because people on the coasts often don't want those power plants in their backyard. And so we have this solution which really may have some very dramatic consequences.

We see very large risks of long-term outages. Mr. Stockton referred to this. What's a long-term outage? It's an outage that persists more than three days. And you get into these knock-down effects with interdependence with other systems. If we were to have a long-term outage, outside assistance probably wouldn't be available for large geographic regions. And we could have hundreds, thousands, or even millions of deaths.

We need to prevent this circumstance. How can

we do this? Well, standards are a part of the solution, but not the only solution. I'll give you a couple examples of standards that would be very important. One is better physical protection standards and especially for large generation complexes. One of the things that I do as I travel around the country is I actually physically visit these sites in person, go to the fence line and look at them. And I would really highly recommend to the FERC commissioners and Staff that they do this as well.

Also, for control rooms, I think that the Commission would be shocked if they were to see how some of the control rooms are situated.

And finally, cybersecurity reporting. In the most recent calendar year, 2015, there was not a single reportable cybersecurity incident for NERC. And this comes to public perception. If we were to have a cyberattack and there was a major outage, how would the Commission ever explain a standard which allows zero reportable cybersecurity incidents.

I'm going to conclude now, and I do very much appreciate the opportunity to testify. Thank you.

CHAIRMAN BAY: Thank you, Mr. Popik.

Mr. Bradley?

MR. BRADLEY: Good afternoon, Chairman Bay and Commissioners. Thank you for the opportunity to join you

this afternoon. I'm Francis Bradley, I'm chief operating officer of the Canadian Electricity Association. We are the association of generators, transmitters, distributors in Canada, investor-owned, publicly owned, and the largest municipals. I'm also, by the way, a member of the CIP committee of North America Electric Reliability Corporation.

Along with our U.S. counterparts, Canadian stakeholders, we share a common vision and the stake in the success of the international NERC regime. Not only do CEA members have equal skin in the game when it comes to security of the North American grid, but the nature of security threats and vulnerabilities themselves demands a coordinated partnership and action, not solutions that are simply pursued in isolation.

So it's in this spirit that my remarks are going to focus on three themes. First, NERC standards and their optimal role going forward; second, increasing importance of effective partnerships; and third, the imperative of applying a North American lens to the pursuit of grid solutions.

So regarding NERC cyber standards, they now need time to mature and to demonstrate their effectiveness. In recent years, we've witnessed significant churn in the modification of CIP standards. Like our U.S. peers, CEA

members have invested unprecedented time and resources in preparing for version 5 compliance. Other people have told you that. Today, you're hearing it with a Canadian accent. CEA strongly believes that these standards must be given a chance to mature with industry-granted sufficient opportunity to cultivate experience and implementation.

With respect to industry government partnerships, there are many examples, and they are proving to be capable of addressing security challenges in ways which are set apart from, but definitely complementary to, NERC standards. Of course, the ESCC is the obvious example. You know, one illustration of the increasing effectiveness of the ESCC is the number of and end nature of initiatives that have been launched since FERC's last reliability conference.

An example, and let me give you one of a new industry/government partnership in Canada which reinforces the value of collaborations, is what's called the Canadian Cyber Threat Exchange, or CCTX. This was launched this year, and it was launched by some of the largest firms in Canada, across the economy. So Air Canada, Bell Canada, the largest railway in the country, Hydro One and so on. This was an initiative that was driven by the CEOs of these companies to develop this cyber threat exchange.

And it's attracting a significant amount of

interest from firms of all sizes. And again, it's further underscoring our robust creative partnerships between industry and government. So while this is industry-led, there is a partnership with key Canadian government agencies, CCIRC, which is the Canadian CERT, and CSE, which is the Canadian equivalent to the NSA, are partners in supporting this initiative. So it's increasingly becoming the key tools for -- in enhancing the grid's overall security partner through these partnerships.

And third is I'd like to briefly touch on the imperative of sustaining a coordinated approach across the North American grid on the security solutions. CEA is committed to continuing contributing to the success of vital forms like NERC and the ESCC, and what's more, we remain confident that security outcomes are optimized when there is a built-in recognition of the need for and value in ensuring applicability of solutions across the North American landscape.

The number of milestones achieved on these fronts continues to grow, a few of which I'll just touch on. Canadian stakeholders remain engaged in numerous ESCC work streams, which have direct cross-border relevance. Major incident response exercises are now beginning to appropriately simulate the likelihood of cross-border impacts of coordinated attacks and natural disasters. The

recent GridEx III is an example of that.

On the margins of a historic state visit in March 2016 President Obama and our prime minister, Prime Minister Trudeau, pledged further cooperation on clean energy. Their plan includes a deliverable on a joint strategy for strengthening the security and resilience of the North American grid. This strategy will be released by the end of 2016 and will address many of the topics flagged for this panel.

These and other actions bode well for cementing grid security as a cooperative North American enterprise going forward. However, sustained vigilance is required to ensure that a continental lens is continually applied to these challenges and that solutions are more effective as a result.

Once again, to the Commissioners, thank you for the opportunity and the privilege to be here today, and I look forward to your questions.

CHAIRMAN BAY: Thank you, Mr. Bradley.

First, I think it's important to recognize the good work that has occurred on cybersecurity, and I think the panelists have mentioned a number of initiatives that have been undertaken.

If you look at the reliability standards, you look at the improvements to the ISAC, you look at the

GridEx exercise, which I think is very helpful in terms of, you know, having industry think through how threats could affect the grid. CRISP and then, of course, the Electricity Coordinating Council, which I think is a very helpful forum for information sharing between government and industry. So I think it's important to recognize the good work that's occurring. My perspective has always been that the reliability standards provide an important baseline level of security. And so that's kind of a foundation upon which you can build your efforts to achieve even more robust security.

So my question for the panel is whether you have any suggestions on what could be done to encourage industry and utilities within the industry to adopt best practices? In other words, using the reliability standards to create that baseline foundation of security, but then, moving beyond that, implement best practices, recognizing that best practices are not, by their very nature, mandatory or required.

Yes, Mr. Popik?

MR. POPIK: Certainly. I would say it's cost recovery. Let's be clear. Utilities are businesses, whether they're a for-profit utility or government-run utility, someone has to pay for these improvements. They can't be done without cost recovery. As a matter of fact,

we have a proposal in front of the Commission for cost recovery for some of these reliability improvements.

CHAIRMAN BAY: Mr. Bradley?

MR. BRADLEY: I can tell you from a Canadian perspective, that is a specific focus of our association's security infrastructure protection program. We take all of the NERC standards and use them as a basis for discussions about what potentially could be best practices. And in a number of cases, we've developed guidelines for Canadian utilities in terms of best practices for implementing a number of the NERC standards. And we shared them with our colleagues over the years at NERC as well.

CHAIRMAN BAY: Sure.

Mr. Sachs?

MR. SACHS: Yes, sir. And I'll just follow up with the same thing. There has to be a return on investment mind-set. If I'm going to do something that costs me, what am I getting back. Part of this might be helpful, as government organizations impose their own best practices, are other things coming back. Are we seeing cost savings. Are we seeing an increase in security. Are there things that we can provide to private industry that says if you do these things, look at what others have already done and have demonstrated this increase security or cost savings.

The idea, of course, is to try and reduce overall risk, and risk reduction is an extensive undertaking. We know that. So can we work together to find ways to demonstrate that if you're performing these best practices, even if you're going beyond best practices and trying something new, provide that information back, through the ISAC or however we're doing it, but demonstrating the reduction in risk and the reduction in costs. Those are the two big pieces.

CHAIRMAN BAY: That's a really interesting observation. Could it be if you were to adopt best practices, that it would be helpful to you as the utility in terms of the insurance premiums you might pay to protect yourselves against cybersecurity risk? I'm wondering whether that can provide some incentive to utilities to adopt best practices.

MR. SACHS: Briefly, there is a lot of interest in the insurance community also to determine what rates should they charge for cybersecurity insurance. So there's an opportunity there for partnership in terms of helping to develop out what do those rates look like and could they be reduced if utilities and others, because this isn't just a utility thing, if there's certain things they're doing and demonstrating to bring those rates down.

This is not unlike what we went through over 100

years ago when Underwriters Labs was created for the utilities to lower the cost of fire insurance because this new thing called electricity was starting to set houses on fire. So we brought those costs down as a partnership with the industry, the insurance industry.

CHAIRMAN BAY: Mr. Ford and then Ms. Dodson?

MR. FORD: Thank you, Commissioner. I think I agree that the standards apply a baseline, but I also would argue that some, if not most, of these standards are best practices. I think the way the industry has developed the standards and how we are going to meet those standards give us many of those best practices we look at.

Outside of those, I agree with some of the comments on risk management. Utilities want to protect their systems. We want to ensure that the reliability is there. We want to ensure to our customers that we are spending the dollars appropriately. So there is that crossover there. But at the end of the day, when it comes to the reliability, it is assessing the risk and then applying appropriate measures to mitigate as much of that risk as possible.

CHAIRMAN BAY: Thank you.

Ms. Dodson?

MS. DODSON: I think it's important to understand the business drivers and be able to bring those

business drivers back into the technology space. And I am a cybersecurity technologist through and through, and I can talk with you all about the bits and bytes of things. And sometimes, I think that takes over conversations, and people want to put it aside because it's hard and people -- I don't understand why I should invest in this.

NIST has a new effort with our National Cybersecurity Center of Excellence where we are working with different business sectors, including the energy sector, to identify the business challenges that people are having in the cybersecurity space and then to be able to understand from a risk management perspective what you will put in place. We're doing this in collaboration with different sectors, but also the technology providers, and building out these capabilities so that you can actually see them in action and have comfort that they do work and they do meet your business objectives.

And as we document this, we are not just writing the words from a very technical perspective, but also providing a one-page business overview of how you do things like access control capabilities for both your IT and your OT systems, as an example, that the electric -- the utility sector brought to us as a challenge that they were having to be able to demonstrate how these really work. I think that's an important aspect where we haven't done a good job

overall, is being able to really demonstrate these in practice.

MS. STREIT: So recognizing that the financial drivers are the primary drivers that affect change, I think there's also on the softer side an ability of the government, for example us in working with our partners, to provide some tools that make it easier to understand best practices and to implement them.

So C2 M2, the cybersecurity maturity model which has been used by over 750 organizations to assess their own best practices is, I think, something where we can help. And I know that we're looking at taking that model and expanding it to look at physical security as well. So there are opportunities there which may not be on the sort of the most forceful end of driving change, but that can facilitate that change nonetheless.

So I would add that to the mix.

CHAIRMAN BAY: Mr. Stockton?

MR. STOCKTON: Mr. Chair, I'm taking your foundational analogy. I think we're in pretty good shape when it comes to mandatory standards for BES entities to be able to ensure they can restore power against traditional hazards. So exercise requirements, training, plan requirements. I'm not sure whether that foundation is fully adequate to restore power in a contested

cyber-environment where the adversary is inside your networks or has established persistent presence through advanced persistent threats. That's a different challenge. A foundation exists for progress. It's a little bit different, though.

MS. SCAGLIONE: On this point, I agree. We do not monitor, we don't have in the standards any prescription of how you would behave once the attack is in place or mechanism can be used for early detection that somebody has entered your system. In the Ukraine case, the attackers were basically in the system for months before they staged their attacks. So it's possible there were warning signs that were not picked up because the information that is used is mostly for reliability, but not for cyber physical security.

CHAIRMAN BAY: All right. Thanks, everyone.

At this point, just given the lateness of the day, I will turn the floor over to Cheryl.

COMMISSIONER LA FLEUR: Oh, my goodness. Thank you for reminding me of the lateness, because I have so many questions in my head.

I first want to comment on the last conversation a little bit. I heard a couple different themes. One is that people might not be adopting best practices because think don't understand the business case or they don't see

the upside, which I do think is a place where communication can help.

On the other hand, if there's somebody who actually doesn't think they can put cybersecurity expenses through their formula rates, I would like to be made aware of it, because I do not -- I think it's a little bit, with all due respect, a bugaboo of cost recovery. I don't think there's actually a lot of cost recovery problems, concrete, that I've heard of, given the way transmission rates are structured, given the Commission's long-standing policy statement on security expenses.

I haven't heard a lot of companies come in and say hey, I wanted to do this, but cost recovery was an issue. So if that is an issue, I would like -- you know, like somebody who wanted to do something but their rate didn't support it, I would like to know. Because I -- it seems to be one of those things you can never kind of put your finger on.

That was more to people who aren't in the audience, or aren't at the panel.

I'd like to think about resilience of how we build the system so that if a major event happens you can pull it back up more quickly. And we've heard about redundancy and making assets critical. We've heard about more distributed resources. That came up a lot in the last

panel.

A thing that just keeps being one of those words people say, but I don't see a lot of action, is standardization and making the grid more modular. Is this something real? Or am I just -- if I were a commissioner for four terms, would I just keep having this every year, well, we're working on standardization? Is there anything really there that we could actually with IEEE or something like that work to make the voltages, the substations, transformers, and so forth more standardized so that if we had a larger-scale attack than the usual physical storm, you know, a -- we could have more interchangeability? Because it's one of those things people talk about, but I'm interested in hearing from these experts what's happening.

MS. SCAGLIONE: In my personal view, not enough. In other words, there have been some efforts in putting security and a lot of the application layer protocols that let these controllers talk, but they are not thinking about making on the power side where these modules you're referring to would be supported by essentially consuming power differently.

There hasn't been -- there is a very scattered idea on how these technologies would work. There are probably technologies, experiments, but there is not, you know, people around the table saying okay, these would be

the standards to do something.

And talking also about microgrids, every microgrid is a work of art. It's a different project. It's like building a big building. There is no standardization plug and play. You cannot put together the systems because they are not often based on standards that make everything compatible and modular.

COMMISSIONER LA FLEUR: Even just normal, normal, not microgrids, like, you know, the 138 to 69 kV or the 345 to, you know, 230 or whatever the voltages are, my experience is that different companies have different setups, breaker and a half, or they have different ways they design their transmission.

Wouldn't it be better if somehow we got it more alike so that if something went wrong we could -- I'm not a --

MS. SCAGLIONE: That's exactly what I was trying to point out. In general, they're controlling not just power. There tends to be this idea that everything has to be hidden property. Right? And instead, the communication industry, totally the opposite. And some point, the system had a turning point where they tried to make everything interoperable and open so that all system devices could be replaced very easily. It's very modular, it's layered and so on.

So that made an open system also vulnerable in certain ways. But the culture is very different. It's just a difference in culture. There are standards, but not to make necessarily everything compatible, but to have reference models that at least will allow you to understand what are the different components.

MR. SACHS: Let me separate physical standardization of components, so that you can actually take a bolt and put it into a little hole where bolts will fit -- but I'm saying physical versus cyber, which is a completely different animal. There's been a lot of talk over the years of trying to standardize cyber, everybody doing it the same way apply the patches the same way, have the same operating systems, so that if you have a computer failure in Kansas City, I can take a computer from St. Louis and bring it over and plug it in.

But the problem with that approach, as we've learned over the years, if you standardize too much in cyber, is because of the chaotic system that you're building, it becomes very fragile. And so a small problem will quickly replicate across a very similar network. Everything's sustained with that small problem with the transmitters.

If there are small differences across a network, a problem won't propagate very easily. That is a huge

piece of resilience here in the United States and Canada. The fact that we encourage through the CIP standards an outcome-based versus a descriptive here are the steps we are -- once you get there so we allow everybody to be a little bit diverse, you wind up where something bad happens, is it doesn't propagate.

And I'll look at Ukraine as the exact opposite. You have three oblenergoes that were attacked almost exactly the same way because they're all doing it the same approach. It's an old Soviet system. There's certainly a meet-in-the-middle place where we want to be where there's likeness, but we don't want it rigid, because if you make it rigid, it's a chaotic system, and it'll fail.

COMMISSIONER LA FLEUR: Well, I was talking more about physical standard -- you know, physical electrical standardization. But that was fascinating, because I thought the trend in the industry was for more people to not make their own home-grown bespoke systems, but the -- you know, all the people like McKinsey and all who come and tell you to buy off the shelf from Siemens or ABB or whatever. And I thought there were more consistent SCADA and so forth. But you say there's a lot of customization.

MR. SACHS: There is, absolutely, and I think we need to encourage that in a framework of security and allow that diversity. That is a huge strength for resiliency.

COMMISSIONER LA FLEUR: Anyone else?

Well, I will yield my time to Tony in the interest of time. And we'll -- if we come back, we'll come back.

COMMISSIONER CLARK: Great. Thank you. And I don't have a lot of questions, just one really. The -- one of the challenges that at least I have as a regulator in this particular area is the issue of prioritization and trying to figure out, okay, in the next 12 months or 18 months or whatever period that we're looking at with regard to the things that are under our control, prioritizing those areas where we can have the biggest impact, and the challenge there is everything sounds scary; right? And there's so many potential vulnerabilities in the system, and it could be GMD. It could be a foreign nation that has hostile intentions toward the U.S. detonating something over the central U.S. bringing the whole grid down. It could be some cybersecurity attack.

And it gets to the point where I think we run the risk as regulators of that old -- I think it's an old military axiom or maybe it's law enforcement, that if you're protecting everything, you're protecting nothing. You just -- you haven't prioritized exactly what you need to do to try to at least bring the risk of worst things happening down but without creating more problems for

yourself by just sort of scattering in all different directions.

So I'm wondering, and I just open it up to the panel, if you had a bumper sticker for here's what the Commission should focus on that has the biggest bang for the buck that should be your priority, what would it be?

And I think I heard some of that from Paul; right? What I heard from you was cross-industry communications where multiple sectors are attacked at once, whether it's communication networks and the power grid, the electric grid, and the pipeline grid. And then black start specifically with natural gas. And I would welcome you to expand upon that or anything else that you wish to.

But if others on the panel have something like that, very concise, here's what the Commission's priority should be where you get the biggest bang for the buck and you're not going in all sorts of different directions, stamping out theoretical problems.

MR. POPIK: I have one. It's installing neutral ground-blocking devices for both solar storm protection and a protection against the E3 pulse from nuclear EMP. The equipment is commercially available. It was developed at private expense. It's been tested at Idaho National Labs. And there's only one device installed in the whole country. They only cost $350,000 per installation. It's a mystery

to me why the utility industry hasn't jumped on this. They'd certainly get a lot less criticism in the press.

And we now even have a National Space Weather Strategy that's talking about the importance of this. I think they just could put aside a lot of the chatter about industry in action if they were to do this, and it could be done right away.

CHAIRMAN BAY: Greg?

MR. FORD: I think utilities plan for all types of contingencies, and we work to mitigate those. We work to ensure we have the proper spare equipment around no matter what it is, whether it's communication side, whether it's transmission, transformers, breakers, and you get into the -- how to build it and get to a standardized point on that and we've developed our system from many, many years of design engineers and everybody doing the right thing to bring it up.

But as we plan for those now and while we're at a point where maybe the way the transmission step-down voltage is in one area to another is not exactly right, what we can do and, I think, what the Commission can help through the CRISP and ISAC and things like that, is the communication that we all have and the understanding of the threats when they come in, making sure that the industry -- hears what those threats are, we can move toward mitigating

those threats, and continue to work together and bring our system together, as we've done, in many instances, where we have a threat that arises.

To say there's that one point that we can look at it, I think from our standpoint, there's probably not that one silver bullet other than how we communicate and making sure that we're getting threat information coming down to the utility so that we can work with the necessary people to mitigate it as soon as possible.

MR. SACHS: Thank you, Commissioner.

I think the mindset has to be one of disruptive or inconvenience problems versus existential problems as in the country. FERC needs to sit at that existential end.

But for something to affect our country, it has to be strategic, and it has to be coordinated. That's what Mr. Stockton was talking about, cross-sector type of thing.

An asset owner is not necessarily going to see that coordinated effort. They're certainly not thinking strategic. The federal government is and has access to a vast network of sensors and intelligence, very smart people, good analysts. We need that help in industry. We need to have that coordinated view. We need to know when things are developing.

Imagine again with Ukraine. Nine months before the attack were the first indications. I'm sure some

intelligence community asset somewhere was picking up on this. That information could have been given to those oblenergoes, they could have taken immediate steps in August, September, October, long before the December attack, could have diffused it. That doesn't mean the adversary might not have chosen a different path, but that type of information sharing, that type of coordination between the government and private sector, I think, is a big piece where we need help. And I don't know if that's a lane that you think is appropriate, but it is certainly an area where we can work together for the resiliency and security of the grid.

MS. SCAGLIONE: Another priority is the distribution grid because in my view, there are a lot of carrots lying there because there is a desire to include all of this innovation in that sector. And that could be paired with the desire of also having a more reliable grid.

If you have a structure which is moduling, also the communication will not necessarily have to rely on the logic that connects the system. That could be local.

Then there are benefits in security that could come together with the investment in place already for other purposes. So somehow entering in that process, encouraging ambitious cycle so that the new technology starts with building security and helps the security rather

than having patches to the current system would probably be easier.

MS. DODSON: I'm going to give you kind of a different answer, and this was my experience working on the framework for improving critical infrastructure, cybersecurity, and something that -- what was brought to our attention at every single workshop and almost every single reply that we got when we asked people what needs to be done, and that has to do with workforce and helping to ensure that we do have the workforce to put into these different environments where cybersecurity becomes part of the culture because it's a part of the training for that workforce.

And I say this because I think there's a lot of emphasis today in the IT space and cybersecurity, and I don't think that it has reached and touched in some of the operational technology space. And Marcus and Greg and others would know better. But people who truly understand cybersecurity are really at a premium. Most of those people understand the IT side. But that crossover in bringing together IT and OT together, I think, is really a big challenge. So I know that's an odd answer for you, but it is something to consider.

MS. SCAGLIONE: I have to say, there have been a lot of efforts and a lot of funding from federal agencies

being spent on universities to create new workforce --

MS. DODSON: The NSA and the DHS, two critical programs, are there, but they're isolated programs. We need to integrate this so that we have a culture of cybersecurity.

COMMISSIONER CLARK: Thank you.

That's all very helpful in helping us think about how to be strategic and purposeful in our steps with regard to the industry.

That's also a very good segue that I should have mentioned earlier on training the next generation of leaders. I need a hat tip to Dr. Scaglione, who I had the opportunity to meet a couple of years ago when she was in her previous position and tour a lab at UC Davis when you were there where they were training those very students, and they were able to even describe for a nonengineer like me exactly what they were doing in their labs, and it was all very interesting.

So thank you for that.

CHAIRMAN BAY: I have one follow-up question, and it's really based on a question that Cheryl asked. Why wouldn't it be possible to standardize at least transformers? How hard would that be to do, recognizing that you wouldn't want to try to swap out the transformers that are currently in place, because they could be

customized transformers, they're very heavy, they take a long time to build and the like? But at least going forward for new transmission facilities, why couldn't there be an effort to standardize transformers? How hard would that be to do? Why hasn't that happened?

Because that's part of -- when I heard Gerry this morning talk about how one of his concerns is an event that can destroy physical equipment, I'm thinking transformers being a real good example of that because they take so long to build, they're so heavy. They can have unique configurations depending upon the facility. So it just seems to me to be an area in which standardization makes complete sense.

MS. SCAGLIONE: I agree. I think it's a cultural problem of the industry. I don't think they think in terms of interoperability of making it easier also to gather data about equipment through standardized interfaces to make it simple to understand, also do the diagnostic and other things. So the missing standards, it's not just the bolt, how it fits, but how it works in the system.

MR. BRADLEY: We have an opportunity for standardization of transformers right now. And the best analogy I could use, many of us have owned cars. We don't get a full spare tire. We get one of those little spare tires. And if you have a flat, you can put it on the

wheel, and you can get to the garage, but it's not going to be as efficient, you're not going to be able to drive 65 miles an hour on the highway.

So we have the recovery transformer program, which was government-financed, DHS. And according to the best knowledge my group has, that unit has been tested in the grid in Texas, but not a single follow-on production unit has ever been ordered by a utility.

I would hope if the utilities got cost recovery they would jump on that. And the spare wouldn't be as good as a permanent replacement, but it would at least get us to the next service station metaphorically or get us to a point where we can recover. And I think that maybe the Commission should have executives from the industry come in and answer the question, why haven't you folks stocked recovery transformers.

MR. FORD: So on the idea of standardizing the transformers, I mean, obviously, we can move forward with something like that. It would probably be very long term in your vision of it. Most of the thought, I believe, when people are out there designing the transformer itself, they're looking at the loading that is specific to that specific area where the transformer is being put in. They size it appropriately for the transmission line that is connecting to it. And so you have differences that built

into the design input.

So that being said, I agree with my colleague, where he was going. We can certainly work towards standardizing and working towards sharing of replacement transformers where we have a fit in one area and a fit in another area.

The ESCC is working with the industry right now to develop a plan for locating and being able to find those transformers and being able to connect a need with a supply, if you will. And I think it would be a good time for FERC to work with the ESCC to help develop that part of, I would say not solving the problem, but getting to a point of having the transformers available so that we can replace them more quickly. That's at the end of the day, is what we're looking to do.

CHAIRMAN BAY: Cheryl?

COMMISSIONER LA FLEUR: Norm and I are dividing up these questions here. Something that came up several times over the course of the day from all of the academics, Dr. Ilic, Dr. Eto -- I don't know if he's a doctor, but he seems like one to me, Dr. Scaglione, was the access to data and the need for open source data for research and analysis. And that's been a tough balance because of the simultaneous need to protect critical infrastructure data from getting into the wrong hands, which was a very welcome

clarification from Congress, giving us more ability to protect it.

But we never really delved into that. Is there a problem with that? Is there something we should be doing? Because we do oversee, and we're on the process now, we're on the clock to do new critical infrastructure standards. I'm interested in hearing more about that.

MS. SCAGLIONE: Yeah, I don't know if FERC is the right authority, but certainly, FERC can inspire legislation that would stimulate the industry to share not the real data necessarily. So there is a gap in research. How will you anonymize, make this data such that they emulate what in practice will happen, but they're not exactly revealing their ability of that specific system. So there is a gap in understanding how would you anonymize it.

And I compare this problem with the problem of sharing medical records. So there is an issue of anonymity, but there is also what you can learn through knowing medical data about patients.

So even in that sector, there is pressure now to identify ways for equating these data or anonymizing this data so that the research can move forward. So it's very different from having the data for operational purposes.

But I do believe that if you have realistic data

and not the simple test cases that we evaluate our methodologies on, then the industry would pay more attention to what the industry is doing because it's not a toy problem, it's something that reflects real issues and is realistically modeled, at least modeled at the level that they model their networks to understand what's going on.

COMMISSIONER LA FLEUR: So how do you get data now? Do you have to go through requests and nondisclosure agreements?

MS. SCAGLIONE: Yeah, and nondisclosures. It's very painful. There's no general format. So every new data, it's a new universe.

COMMISSIONER LA FLEUR: Ms. Streit?

MS. STREIT: Thank you.

So I was thinking about that question also when Marcus was speaking about the sort of lack of information from his end. We -- I think there is -- I think the situational awareness information that we have in the moment is not as good as it could and should be, and getting that information is also a challenge, and for some of the reasons that have been brought up here and just some practical ones.

And to your -- so that's one of my priorities, actually, is trying to figure out how to do a better job of

that, and I would love to work with any and all and sundry to tackle that.

From the research perspective, one could imagine a future in which we would have enough historical information, sufficiently far in the past, right, that we would be able to make that available to a research community to run the what-ifs and the what-might-have-beens. And so when I dream in the middle of the night, that's one of the things that I think about, but that's a ways out.

MR. SACHS: And I agree that data collection is extremely important, not just for universities and research, but even for us to understand what's going on, for you to understand what's going on, DOE. All of us need to have access to information.

I think what's stumbling recently is, as you're well aware, when you start to pool information, you now create a vulnerability, because what had been dispersed is now concentrated. And if an adversary gets that concentrated information, other unexpected results could happen.

And as the recent years have shown, it's very hard to protect even things like my security clearance and other cited examples of where we are deliberately trying to protect information, but yet the adversary finds a way to

get in.

So there is fear amongst industry and others that if we pool too much stuff, you just can't protect it. The best protections still aren't working. And I realize that's a bit of a counterargument. It speaks to the realistic world we live in in 2016. We all have got to figure out how do you pool information and keep it secure at the same time or pool it in a way -- and maybe this is where science can help us, even if it's pooled, it's meaningless to somebody else. Maybe some crypto could help us there.

MS. SCAGLIONE: From the research case, I think it is simpler, because you are asking questions. So as long as you have data that is not necessarily specific and real, but theoretically can use the same type of facts, you can make conclusions. And so these could be happening on anonymized data that are similar in trends but are not specifically revealing any vulnerable point.

MR. STOCKTON: Commissioner LaFleur, I have a slightly different recommendation, just to be brief. We need a higher fidelity view of the status of the grid as it operates and as it might be attacked. Gathering data from a larger number of PMUs, to be able to correlate the sensor data, be able to make sense of it so there can be a nationwide view of what's going on to facilitate

situational awareness and rapid attack detection, that is extremely important.

MS. SCAGLIONE: And to this point, I have access to some data, I can show on the difference in SCADA data in terms of detecting.

COMMISSIONER LA FLEUR: You're talking about in that awful case where the emergency authority that you referred to in the FAST Act gets used, what data will the Secretary be acting on? Not phone calls, we hope.

MS. STREIT: Certainly that. But I mean, the way we get our current outage information is by scraping public Web sites.

COMMISSIONER LA FLEUR: Is by what?

MS. STREIT: Is by scraping public Web sites.

COMMISSIONER LA FLEUR: Well, I just will mention that this conversation is deja vu all over again from the conversation we had at the GMD tech conference about data and professors needing it and all. And I do appreciate the counterargument very much. I mean, I testified in favor of a FOIA exception for critical infrastructure information after some recent events made it difficult to protect it. So this has to be a problem we can solve in order to get the power of the information.

Thank you.

CHAIRMAN BAY: Colleagues, any closing remarks?

No?

All right. I'd like to thank our panelists for coming here today. I really appreciate your very informative presentations.

Thank you very much, and with that, our technical conference is concluded.

COMMISSIONER LA FLEUR: I also want to thank the Staff for this always. Every day, we thank the Staff every day.

CHAIRMAN BAY: As we should.

Thank you.

(Whereupon, at 4:55 p.m., the technical conference was concluded.)

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This is to certify that the attached proceeding before the FEDERAL ENERGY REGULATORY COMMISSION in the Matter of:

Name of Proceeding:

IN THE MATTER OF:
RELIABILITY TECHNICAL CONFERENCE

Docket No.: AD16-15-000

Place: Washington, DC

Date: Wednesday, June 1, 2016

were held as herein appears, and that this is the original transcript thereof for the file of the Federal Energy Regulatory Commission, and is a full correct transcription of the proceedings.

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