2018 Reliability Technical Conference
Regarding the Bulk-Power System

Docket No. AD18-11-000

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Federal Energy Regulatory Commission
Commission Meeting Room
888 First Street, NE
Washington, DC 20426

Commissioner Neil Chatterjee
Commissioner Cheryl LaFleur
Commissioner Richard Glick
Commissioner Robert Powelson
Barry Kuehnle - Critical Infrastructure Protection Senior Advisor, Office of Energy Infrastructure Security
Larry Parkinson - Director of the Office of Enforcement
Panel 1 Panelists:
Jim Robb, CEO, NERC
Tim Gallagher, President and Chief Executive Officer of ReliabilityFirst
Sylvain Clermont, Director, Operational Technology Convergence, Hydro-Quebec TransEnergie, on behalf of the Canadian Electricity Association
Commissioner Marcelino Madrigal Martinez, Mexican Energy Regulatory Commission (CRE)
William Fehrman, President and CEO of Berkshire Hathaway Energy, on behalf of the Edison Electric Institute (EEI)
Eric Schmitt, Vice President of Operations, California ISO
Steven Naumann, Vice President, Transmission and NERC Policy, Exelon Corporation
Jack Cashin, Director of Policy Analysis and Reliability Standards, American Public Power Association

Panel 2 Panelists:
Mark Lauby, Senior Vice President and Chief Reliability Officer, NERC
Wes Yeomans, Vice President of Operations, the New York Independent System Operator
Peter Brandien, Vice President of System Operations, ISO New England
Bob Bradish, Vice President, Transmission Planning and Engineering, American Electric Power
Carol Chinn, Chief Information and Compliance Officer, Florida Municipal Power Agency, on behalf of Transmission Access Policy Study Group (TAPS)
Tom Galloway, President and CEO at North American Transmission Forum
Alison Silverstein, Independent Consultant
Panel 3 Panelists:
John Moura, Director, Reliability Assessment and System Analysis, NERC
Dr. Damir Novosel, President, Quanta Technology, on behalf of IEEE Power & Energy Society
Roy Jones, Chief Executive Officer, Electricities of North Carolina, on behalf of the Large Public Power Council (LPPC)
Jay Bartlett, President and CEO of Wabash Valley Power Association, on behalf of National Rural Electric

Cooperative Association (NRECA)
Nicholas Miller, Principal, HickoryLedge LLC
Peter Gregg, President & CEO, Ontario's Independent
Electricity System Operation (IESO)
Panel 4 Panelists:
Bill Lawrence, Director of the E-ISAC, NERC
Carol Hawk, Acting Deputy Assistant Secretary for
Cybersecurity
For Energy Delivery Systems, U.S. Department of Energy
Vincent Sritapan, HSARPA Program Manager, Department of
Homeland Security
Matt Rathbun, Chief Security Officer, Microsoft
Paul Crist, Vice President, Technology Services and CTO,
Lincoln Electric System
Ben Miller, Director, Threat Operations Center Dragos, Inc.
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Opening Remarks and Introductions

COMMISSIONER CHATTERJEE: Good morning everyone. Thank you all for being here today. Chairman McIntyre very much regrets being unable to join us today and he has asked me to Chair today's Conference in his absence.

He's asked me to convey that he appreciates the rich tradition and history of these Reliability Tech Conferences. Chairman McIntyre also asked me to note that he's especially proud that the Commission has added a panel on resilience and he hopes that the Commission gets solid input and advice today on that matter.

Lastly, he wishes to extend a warm welcome to all panelists with a special welcome to Jim Robb. The Chairman greatly appreciates how Jim has taken charge of NERC and looks forward to working with Jim in the coming years.

I second the Chairman's remarks and would also like to welcome Commissioner Marcelino Madrigal from the Mexican Energy Regulatory Commission who is joining us on the First Panel today, welcome Commissioner.

We also have with us today in the audience Ken DeFontes who is the Chair of the NERC Board of Trustees and Frederick Gorbet who is a NERC Board member. Again, I thank all of our distinguished visitors, our panelists as well as all those who are attending today's Conference both in

person and remotely.

Before we get started I'd like to briefly preview the Agenda which includes a host of interesting and timely topics. Our First Panel today will discuss the significant changes that have occurred with the ERO Enterprise over the past year, particularly at the regional entities including new initiatives and expanded cooperation with Mexico.

The Second Panel will focus on issues related to resilience. I expect this discussion will provide an opportunity to build upon the extensive comments submitted as part of our ongoing resilience proceeding prior to today's Tech Conference.

As the Commission's January order on the issue stated, resilience and reliability are related by separate concepts. I look forward to working closely with my colleagues and staff in reviewing the record compiled in our resilience proceeding to better understand how the rapid pace of change in the nation's generation mix affects those issues.

As I'm sure you all know, I've been very vocal in expressing my viewpoint that we must examine this concern now, so that we may avoid a situation at some point in the future whereby we regret not having asked the hard questions when we had the chance.

I know the Chairman has the same goal in mind.

My hope is that we can use the discussion today to advance the conversation on how we can insure that our grid remains reliability and resilient in the years ahead.

Our Third Panel will explore challenges and opportunities arising from the historic changes we are experiencing in our electric grid. I'm particularly looking forward to hearing our panelist's thoughts on how the advancement of potentially transformative technologies like electric storage and distributed energy resources could affect bulk power system reliability.

Our Fourth and Final Panel will examine growing and evolving cybersecurity threats and the need for heightened security measures. Staying on top of the rapidly changing cyber threats to our grid has been a top priority of mine since joining the Commission and I'm interested to hear from this distinguished panel.

In particular, I'm looking forward to exploring the future of the NERC CIP Standards, and how we can facilitate greater and more meaningful information sharing between the private sector and government.

I know I speak for my fellow Commissioners when I say that we are sensitive to the fact that our cybersecurity actions must strike an appropriate balance between need and compliance burdens. That is to say NERC must have timely, accurate and actionable information that is proportionate to

the threats to our grid without placing an overly prescriptive or unmanageable compliance burden on industry.

Industry's active engagement in FERC proceedings and the NERC stakeholder processes are essential in helping us strike that balance. I see today's panel as an important part of that ongoing dialogue as we look at the characteristics and elements of an appropriate balance.

Now one last note before I move on to a handful of housekeeping issues for today's conference. I think it's important to underscore that the reliability of the nation's bulk power system should not be a conversation exclusive to the Commission.

Of course, ensuring reliability is among FERC's core statutory responsibilities but our state and federal regulatory partners, and increasingly our international partners also contribute to our work in insuring the reliability of the grid.

To provide just one example, in a moment of crisis the communications network, regulated by the Federal Communications Commission, could prove important to keeping the lights on to.

With this in mind, FERC has and will continue to invest considerable time and energy in working with our government and industry partners to prevent the development of regulatory silos that could adversely impact reliability.

But with that I just have a few housekeeping matters to review before I hand the microphone to my colleagues and to a few of our distinguished guests for their opening comments.

There's no food or drink allowed in the Commission meeting room here except for bottled water. Commissioner Powelson, I'm sorry, bottled. We also ask you to turn off your cell phones. For Wi-Fi access there's a paper on the table outside that says "Guest Wireless Network Rules of Behavior that includes the instructions."

Now I need to read a statement that is now part of our opening at all the Commission meetings here in the Commission meeting room.

Members of the public are invited to observe, which includes attending, listening and taking notes, but does not include participating in the Conference or addressing the Commission. Actions that purposely interfere or attempt to interfere with the commencement or conducting of the Conference will inhibit the audience's ability to observe or listen to discussions, including attempts by audience members to address the Commission while the meeting is in progress are not permitted.

Any person engaging in such behavior will be asked to leave the building. Anyone who refuses to leave voluntarily will be escorted from the building. And

finally, we will not have a general Q and A with the audience during the Conference.

However, we will be accepting written post-Technical Conference comments in Docket Number 8018-11. Expect to see a formal invitation for those comments to include submissions deadlines in the near future.

So with that let me turn to Commissioner LaFleur for any opening remarks she may have.

COMMISSIONER LAFLEUR: Well thank you very much Commissioner Chatterjee and I join you in welcoming all our guests here today in the room and electronically. I think you covered a lot of the VIP's but I just want to call out that we have the Chief Executives of most or all of the regional entities who are a very important part of the electric reliability enterprise.

With us, Tim Gallagher on the panel and I see Sara Patrick and Melanie Frye in the front row who are both relatively new to their roles running the MRO and WECC and of course I spoke with several others before so I'm very happy to have you here because that's where the rubber hits the road in this world that we're talking about.

This is the day I look forward to every year and every year I try to find something that makes that year special -- like it's been 10 years since the Energy Policy

Act, or 5 years since NERC was certified or something, but it's pretty easy this year because as Jim Robb's testimony pointed out we are celebrating 50 years since the formation of NERC in the aftermath of the 1965 blackout which I well remember.

I was practicing piano when the lights went out in Boston and of course, then not a round number but 12 years ago NERC's role fundamentally changed when it was certified as the ERO and the standards became mandatory.

I think that the Chairman and Staff have put together a terrific agenda of some of the key topics before us, particular -- I'm particularly interested in the transformation of the resource mix and how that impacts the NERC work and as well as cybersecurity.

And in each of the areas I'm really interested in pushing on -- among all the tools that FERC, NERC and the rest of the ERO have before them, when do we go to standards, when do we use assessments, when do we use alerts, how do we -- how do we flex these various tools -- especially when do we decide that an issue is ripe for a standard among all these emerging issues?

Are we admiring the problem too much? Should we move on to action or are there some things where we've moved to action too quickly? And I think that's teed up in quite a few of the discussions I read in the pre-file testimony.

So I look forward to a great day. Thanks for the time Neil.

COMMISSIONER CHATTERJEE: Commissioner Powelson?

COMMISSIONER POWELSON: Oh, it's like Lee Iacocca, it took him 36 months to leave Chrysler so I'm still here. Thank you Commissioner Chatterjee and Commissioner LaFleur for your opening remarks and Commissioner LaFleur, 1965 I was a pre-conceived notion from my parents that I'd be a Federal Energy Regulatory Commissioner, but I wasn't born until 1969 so.

But I want to take this opportunity to also thank our panelists here this morning. I think we all agree that the issue of reliability of our nation's energy infrastructure is a critical issue -- both federal and state.

And I think Commissioner Chatterjee set it up nicely -- this conversation, as I learned from my prior life, this ability on the cyber discussion -- and I comment Joe and David for the work that they've done, is kind of breaking down these silos and working in cooperation with our state partners is so critically important and I'm looking forward to that discussion.

But it is certainly getting interesting here and in terms of this overall goal of achieving reliability in our bulk power system and, you know, the work that NERC has done -- and Jim, you really hit the ground running. I will

applaud you.

More recently I caught your LinkedIn post -- I might take a little bit of exception with some of it but we'll have that conversation here shortly but I think NERC is really the driving force in this conversation and I look forward to hearing about the work that each of you have done on achieving reliability as well as recommendations for future improvement to our bulk power system.

This issue, as I said earlier, could not be more timely considering the Commission's ongoing resilience proceeding. It will be interesting to hear from the panelist views on the topics of reliability and resilience and how they differ as well as how the two ideas intersect and complement one another.

Let me add -- and I think it's fair to say as a long-standing former EPRI Advisory Board, the work that EPRI has done in this -- in these areas has been critically important to today's conversation as well.

I think it's fair to say that the grid of 1965 Jim, has evolved radically. In fact over the last decade we've seen this -- the tectonic shift in our energy mix. It's been great for consumers, it's been great for the environment and our conversation today also will recognize some of the disruption on the horizon.

We talk about weather related events such as

Hurricane Sandy, the recent or the polar vortex of 2014 and the recent bomb cyclone and how these type of weather events, and more recently the tragic events unfolding right now in California with the wildfires and the impact it's having.

I think today's conversation we're going to be teeing up some timely conversation about not only bulk power system reliability, but more importantly the work that continues to be done in this area. So again, Commissioner Chatterjee, thank you for convening today's hearing and I look forward to the panelist presentation here this morning.

COMMISSIONER CHATTERJEE: Commissioner Glick?

COMMISSIONER GLICK: Thank you Commissioner Chatterjee. I, too, want to welcome everyone here today and also want to personally welcome Jim Robb who is attending his first Reliability Conference as the NERC CEO. Jim was nice enough to invite me recently to a NERC Board of Trustees meeting which I found very interesting and very helpful.

And I know that over time the FERC/NERC relationship has maybe been a little rocky at times but I think it's gotten a lot better, but I know it's going to be a very good and productive and well-thought out relationship with Jim in his new capacity so I look forward to working with Jim and everyone else at NERC.

Promoting -- and I do want to talk about the '65 blackout because I was there too, but my parents told me I cried like a baby, so I don't remember -- but promoting the reliability of the bulk power system should be and is a top priority for the Commission and the discussion that's going to take place today is going to help us carry out our responsibilities under the Federal Power Act and I look forward to today's dialogue.

I just wanted to take a minute to make three points before we get started with this Technical Conference. First of all, as everyone knows that's been mentioned, we're in the middle of a dramatic transformation in the electric industry and these changes offer substantial benefits but they also present a few challenges and some of them are reliability challenges.

And I believe we need to embrace these changes and tackle the challenges rather than seek a return to the grid of the 20th Century. Second, and it's a topic that we had spent a lot of time talking about -- the cybersecurity of our energy infrastructure is absolutely essential and I'm sure that everyone has seen the media reports that the Russians are targeting our energy system so they may hold the capability to do serious harm.

As Director of National Intelligence, Dan Coats recently noted the red warning lights are going off about a

Russian cyberattack and we all need to take that seriously and I know we're going to talk about that some today.

Finally, and I know that we're going to also talk about grid resilience today which is the topic de jour of most meetings that we go to these days, and I welcome the discussion because we should be doing all we can to ensure that the grid is protected during extreme weather events that Commissioner Powelson mentioned and other events like that.

But we also need to be careful not to let resilience be used as an excuse by some to achieve the results they haven't been able to get from the capacity of energy markets in the various regions around the country.

I feel that is exactly what some are attempting to do with this topic and we need to be very weary of that on a going forward basis. So thank you and I look forward to today's discussions.

COMMISSIONER CHATTERJEE: And now Commissioner Madrigal and Jim Robb would each like to make a few opening remarks, Commissioner?

COMMISSIONER MARTINEZ: Thanks Commissioner, thanks all Commissioners on FERC, thanks for the invitation, we're really happy to be here looking forward to learning. Mexico power sector is undergoing a fast, deep and wide transformation towards a more competitive energy sector. In

this context, we with our Commission in Mexico became the regulatory of Mexico and that's barely four years ago so we're new to this business.

Since the unity reform market in over less than four years, CRE has successfully ended up taking the newly given role of a reliability utility issuing important regulations and reliability, supervising its compliance and reporting already on the status of reliability in Mexico for the first time with public documents available to the public.

Reliability performance in the Mexican power sector has been good and adequate with some of improvement that has been identified recently. We have a relationship with NERC that has been very useful to inform some of our decisions. It has also helped us increase our capacity in areas of increasing interest to us such as cybersecurity and operational reliability of systems with large shares of variables and new rules of renewal energy and has been very successful in Mexico and with that we are very interested in keeping our system reliable as we implement our clean energy agenda.

So with that we look forward to this Conference, to learn from you. Keep exchanging ideas and again taking this opportunity to thank NERC and FERC for the coordination we have had so far. We are looking forward for the

discussion today, thank you very much.

MR. ROBB: Thank you Commissioner, and Commissioner's I appreciate all of your gracious comments welcoming me to this -- to this role. I'm honored and humbled to occupy the chair that I occupy. I've been on the job for about four months. I spent most of that time listening and learning to many of our constituents and I would have to report to you that I really like what I've seen and heard.

I think there is among the staff at NERC, a high commitment to the reliability and security mission that we're charged with and in my discussions with the many stakeholder organizations a strong desire to see it succeed in the work that we do.

My focus, as I've said at many forums, is really around implementing the risk based philosophy that we established as the ERO enterprise leadership over the last several years and really embedding that in all of the activities that we undertake.

We're currently in the middle of a thorough review of our standards looking to make them more efficient and effective for industry focusing on the big real issues that relate to reliability and maybe clearing out some of the duplication and more administrative requirements that are placed upon entities.

And the second piece of this is really focusing on consistent implementation of our programs across the 7 regional entities. It's clearly a challenge, it's clearly an issue that industry wants to see us get better at and the regional executives and I have all stacked hands that we're really going to crack that code in the next -- in the next little while.

As we do this we're going to keep our focus very much on the big issues and the important issues that drive reliability. We're going to try not to be distracted by the trivial but I will commit to you all that we are going to maintain rigor in our work at all times because that's very, very important.

My personal view of risk priorities for us align very well with the agenda that you've all laid out today so it's nice when a plan comes together, but the issues that weigh heavily on my mind are security -- both physical and cyber.

We're in the middle as you all know of a real renaissance in the work we do through the ISAC and I'm very, very excited about the long-term strategy and the more tactical plans that we put in place to make that a very strong asset for the -- for the industry in protecting the grid.

The restructuring of the western interconnection

and the fragmentation of the reliability coordinator is a very important issue for us all to pay attention to. I'm very gratified with collaboration that we have with WECC and a number of the large entities in the west to make sure that that transition happens in as seamless a manner as possible.

And then finally and probably most importantly, the issue that will occupy a lot of our attention is sustaining the reliability and the resiliency of the grid as we transition from the 1950's energy mix that we all grew up with to the one that we're seeing evolve over time.

And that means that we insure that we're preserving all of the essential reliability services that are required to make the grid operate effectively, that we learn how to effectively integrate inverter-base technologies -- be they solar, be they batteries, so that they contribute to the reliability of the grid.

And then finally that we have our eyes open to the fuel assurance issues surrounding the increasingly essential role of natural gas in integrating all those other resources.

Today's Conference is heavily focused on the work that NERC does around the state of reliability report. I wish I could take credit for that one but it was well in progress before I showed up. I'm very proud of the report and I'm proud of the findings in it.

We are now at the point where we have datasets and history adequate to really statistically evaluate the reliability of the interconnection and it shows a very sustained year-on-year improvement across the industry and that's something we should all take a lot of pride in, so there's very clear demonstration of industry performance.

Anyway, I very much look forward to today's discussion and I appreciate the opportunity to make a few opening comments, so thank you.

PANEL 1: The Changing ERO Enterprise, Standards, and Reliability

COMMISSIONER CHATTERJEE: Thank you both for your comments. I think how we're going to proceed from here -- similar structure to what we've had in our open meetings. My colleagues and I will go through and ask questions and I believe we have until 10:45 on this panel and so should there be time remaining at the end of the panel I'd ask the senior staff at the table if they have any questions for our distinguished guests to go.

But with that I'm going to kick-off the questioning with you Mr. Commissioner, thank you again for being with us today and appreciate your remarks. Reliability is unique -- out of all of the issues that we deal with because the integrated nature of our North American grid, so I really, really appreciate your

participation here today.

I was hoping you could elaborate on where Mexico stands with respect to recognizing NERC as the ERO and implementing mandatory and enforceable standards. Is that something that the Mexican government is considering or are you anticipating a more informal collaboration for the foreseeable future?

COMMISSIONER MARTINEZ: Thank you Commissioner. I think it's important to mention that our systems have been historically interconnected in the California region. Mexico has had a relationship for many years with WECC especially, so the Baja system, which is now interconnected with the national system we actually have implemented a standard that is exactly the same as California.

We have a set 7 standard that are basically the same as the standards used in WECC, so where the past administration in -- we have signed a memorandum for understanding with NERC to basically exchange information, study, best practices and also study the potential, you know, use of all of the standards in the rest of the country.

As I said the part where we are highly interconnected is basically Baja, California and there we use standards already used in the U.S. So regarding how do we see this evolving I think it's good to react on what has

happened over the past few years and on reliability standards, our teams have implemented a comprehensive review of the standards used in the U.S., some of which will be submitted to our Electrical Reliability Committee who's in charge of reviewing our grid code and then basically this Committee takes the decision to put forward these revisions to us at the Commission.

So we have basically established already a Reliability Committee very similar to the ones you have here to process revision to the grid code. So there are some standards that we put forward to the Commission for consideration. I just wanted to mention that we have been using standards in Baja, which are basically some of the same in the U.S.

We have also conducted reliability assessments together with NERC. They also witnessed our restoration process implemented by CENACE. I think it's good to mention that the exercise which occurred in Mexico and we hear from NERC that they were surprised about the quality of the process that is -- there are always some areas of improvement and we are working on that.

Cybersecurity -- we have covered solar and learned from what is happening in the U.S. Our staff has witnessed the grid exercise in coordination with NERC. Our grid Code already includes some guidelines of cybersecurity

based on the things we have learned from you and it's important to mention that we -- the Commission have authorized some investments for the system operator to implement some actions on certain actions on investments on cybersecurity.

We are in charge of approving our system operator. The requirement as I said, does include some investments for cybersecurity so moving forward us -- we have seen our relationship very, very fruitful. We are working right now under an MofU with NERC.

In California we have a formal relationship with WECC that continues, is ongoing. So CRE's is willing to take reasonable steps to study different and all-expanded models for participation in the Electric Reliability Organization in accordance, of course, with Mexican legislation.

We are we -- we detailed in Mexico and the Minister of Energy has some policy decisions to make on that so the Office of the Chairman has actually communicated with NERC and described the roadmap or process or steps that CRE is willing to take to expand this role.

This would be feasible only in the midterm since Mexico is under a federal government transmission period for most of the remainder of the year, but we remain committed to look at all potential alternatives to continue our

relationship.

I want to spell it out that our relationship with WECC has been there for maybe more than 20 years. I just mention that the Commission took the role of reliability of authority to use four years ago. We spend some time sort of changing the agreements because your counter-party in Mexico was the utility now you are counter-party.

We were able to process that arrangement and now with NERC on working on MofU has been very useful. As I said moving forward sort of engaging with NERC as all the providences in Canada, it will take some time but we're willing to take some steps to engage and enhance our relationship that has been definitely very, very useful.

COMMISSIONER CHATTERJEE: Can you identify any cross-border reliability issues that our Commission should be jointly focused on?

COMMISSONER MARTINEZ: Our sort of -- most of our interconnections in terms of size are in California. Our system as you can see in my written statement -- is fairly reliable. We haven't had any major events. In California, especially, we have supported the U.S. and once in a while the U.S. has supported us.

So in terms of reliability issues in the interconnection I don't see any major events. What I see sir, is reciprocal sort of support in California and Mexico

but I don't see any special reliability issues in cross-border interconnections.

Our cross-border capacity interconnection is still incremented in most of the states except California, so cross-border wise I don't see any issues. Internally we have some of the things you have here also in the U.S. -- heat waves that are out of any predictions. Heat waves, stress our infrastructure in some parts of the mainland in the north and in the central part of Mexico.

We also have issues with building transmission on time. As maybe in other countries it is environmental and social aspects that we taking care of very well, so transmission infrastructure may not be growing as quick. We are doing very well still because our reliability report has concluded that distinctive reliability is good so ready for improvements -- nothing especially in cross-border, just a mutual beneficial relationship so far.

COMMISSIONER CHATTERJEE: Can you briefly touch on the evolution of markets in Mexico and how the development of those markets might impact the U.S.?

COMMISSIONER MARTINEZ: Yes, with the energy reform as you may have heard we basically have opened up the industry to competition. We have in a period of less than 3 years very -- what I would consider my true wholesale markets, we have contracted more than 6 gigawatts of mostly

renewables because we have happened to be very competitive in our design technologies compete freely, but the reality has been that renewals have been very competitive so we have contracted about 6 gigawatts of renewables, which is more than the country has built over the past 15 years.

So wholesale markets are very liquid, we have strong competition. In a period of less than 3 years we have more -- sorry, more than 35 new companies generating in Mexico so big opportunities in Mexico.

On the rate pay side the market is also starting to evolve. We see a tremendous price of generation on the edge of the grid. Distributive generation is growing exponentially. We don't have subsidies or feeding tariffs, it's just pure market-based investments -- around 60,000 consumers have opted to use distributed generation.

We have a very interesting scheme that we issue at the Commission so both the wholesale and the retail market are evolving very well. On that we have seen entries from companies in the U.S. to be more cross-border infrastructure. Those are very small investments.

If we look at the size of Mexico in the U.S. but very special opportunities in cross border capacity interconnections between Arizona and also California but in terms of the size they are still rather limited.

So bounds of opportunities, the sector is working

now on a competitive basis. Market rules are issued independently, we monitor a 360 market so definitely more opportunities for mutual beneficial relationships.

COMMISSIONER CHATTERJEE: Thank you again for your comments and your participation. I look forward to continued dialogue. Mr. Gallagher, and thank you also for being here. In your prepared testimony you talked about reliability first efforts to go beyond compliance with proactive assist visits.

Can you talk about that effort and some of the lessons you've learned and if you could also elaborate on whether you think that could be scaled up across the country, we'd be very interested in this.

MR. GALLAGHER: Thank you Commissioner. We're very proud of that program and we started it about 6 years ago and our objective when we started it was to do three or four of these a year and now we do over 100 of them a year -- we're fully subscribed and we're actually running out of talent to perform them.

The Assist Visit program is proactive. It's voluntary. And there really are two types and they can focus on a specific issue so they can be a one and done or it could be more of a long-lasting engagement if a company is struggling in a particular area.

So the two types -- there's a remedial type and

we do use these a lot in the CIP space where a company has systemic issues across all of the suite of six standards in their security posture. And actually we will engage -- key members of my staff will engage in participating with that entity on a day-to-day basis at times and rebuilding that program.

Often it resorts to correcting cultural problems, removing silos, we've actually learned a lot along the way and we've written and partnered with WECC and Cirque now on a report that's lessons for other companies so that they don't fall into the same space.

And the companies that were in this space actually helped us author that report so you're getting true feedback right from the field. The objective of those remedial type of CIP visits is first of all to mitigate the deficiencies and to improve the security posture.

We've learned over the years when the problems are this systemic, if you take a traditional regulatory approach of finding an issue and coming up with a specific mitigation for it, it's not going to work because you need a holistic solution and sometimes you have to start really at ground zero.

So the goal is to rebuild that, take the bottom core talent performers, make them top core talent performers and also make it a sustainable program because

sustainability is key. The other type of CIP's visit is a more proactive one and this one again is voluntary. What drives it is issue spotting or potential risks that we see.

We use maturity models and maturity models are nothing new -- they've been used for decades in the IT industry. It's just a little bit new in the way we're applying it in our work with the entities that we partner with.

The goal here is to understand where they are with their management practices. That will lead to a more sustainable compliance program, but more importantly lead to continuous improvement and excellence -- that's what we're trying to achieve in that.

We firmly believe that compliance is extremely important, standards are extremely important -- that's our backstop. But if we can help companies achieve excellence in their operations and build a sustainable program the compliance will sort of fall out of that.

In terms of the scaling -- we have been doing partnering with other regions to demonstrate the benefits, the virtues and the tactics that we use in these. We're partnering right now with FRCC and Cirque to do some work here and also we do have sort of disciples.

Once we work with a company it becomes organic and those companies will talk to other companies about the

experience that they had.

COMMISSIONER CHATTERJEE: Really appreciate it and thank you for the effort you're putting into this. Mr. Naumann, I also appreciate the analytical framework that you laid out for considering how to evaluate resilience and fuel security.

I thought it was consistent with comments I made in an op-ed in the Washington Examiner several months ago. You suggested in your testimony that NERC should insure fuel security remains a high priority. But as a practical matter, what steps do you think NERC should be taking to move the ball forward on fuel security or to put it another way -- what do you think is the appropriate role for NERC in helping to address the issue of fuel security?

MR. NAUMANN: Thank you Commissioner. I think NERC has performed that role and continues to perform that role in its assessment process. Starting a few years ago NERC proactively identified fuel issues as an interdependency possibly impacting the reliability of the bulk power system.

That's shown up as we saw in my pre-filed testimony in the 2017 long-term reliability assessment and even more directly in the single point of disruption special assessment on natural gas.

And if you look, you take that kind of

assessment, you look at the recommendations in that assessment and there were a number of them -- some of them to regulators and all they are, are recommendations. They're saying regulators should look at fuel diversity. Planning coordinators should do their studies, their evaluation for loss of guest facilities, dual fuel units should be evaluated for what they can do and there are a number of other recommendations.

So NERC's strongest area in my view on fuel security would be to continue to do assessments and as NERC learns more information because this really is difficult every time you do something you peel the onion, you find out something else and you learn more.

So as I understand it and Jim Robb can correct me if I'm wrong, the latest special assessment on the potential impact of early retirement of baseload units is due to go to the Board in November. That again, should provide both regulators, policy-makers, stakeholders with more information to then go and go forward and decide.

So within the assessments -- and then if there were an event which their -- like the polar vortex for example, which was an event for a number of reasons to do their event analysis. Those are the two areas that I would think are strongest with NERC.

I think standards for reasons I've said in my

testimony -- the interdependencies, the jurisdictional issues, I think are a much -- on a greater lift.

COMMISSIONER CHATTERJEE: Jim, do you or any of the other panelists want to comment on this topic?

MR. ROBB: Yeah, I think this is one of -- probably one of the most important issues that we need to kind of collectively get our heads around is that many of the changes going on right now have their roots in solutions that will not come very, very quickly.

For example in some areas the work that we did at WECC clearly calls for expanded infrastructure of the natural gas system -- well that's not going to spring up overnight. And I agree with -- I agree with Steve that the assessment process that NERC has is a terrific one for spotting issues that are evolving and coming down the road and hopefully sparking conversation into action.

I think -- and I agree I think that's clearly one of the focus areas for us. We do have some work underway though around fuel assurance and we had a technical conference early July where kind of my change to the group was to kind of make the pivot away from admiring this problem, because it's been pretty well admired, and really start to shift toward what set of actions can be put in place to assure that we have the infrastructure, the capabilities, the syncing up of operating practices between

-- the high focus on natural gas and the electric system to make those industries compatible and harmonious because the role that natural gas is playing is very, very different than it's played in the past.

And we see that, you know, most pronounced in California with a lot of issues we've uncovered coming out of the retirement or not the retirement but the restrictions around Aliso Canyon and being able to supply gas to the southern California plants.

So we are looking at the standards that we have in place now. We're in the process of evaluating the need for a guideline around -- as companies do their routine planning assessments to expand that into looking at their fuel supply -- and I'm talking fuel supply here, not just natural gas because this needs to be a fuel blind issue -- identify areas of concern and propose corrective action plans against that.

So I think that's one tool that we're going to continue to push on. The assessment's clearly an important -- an important part of that and we're not closed minded to the possibility of a suite of standards if indeed they're required. I think at this point in time we haven't made that leap that we think that we need to go to the step of creating a fuel specific standard.

We can address it through some of the existing

processes that we have, but it's clear that industry wants more guidance around what they should be studying and what sort of corrective actions they should be contemplating, so we'll provide that.

COMMISSIONER CHATTERJEE: Thank you, turning to Mr. Fehrman, in your testimony you noted in your extensive engagement with E-ISAC and the importance of continuing to build out the ISAC's capabilities. Given your experience with the ISAC, what do you think are the most important strategic priorities or capabilities they should be focused on developing?

MR. FEHRMAN: Yes, thank you Commissioner. So I have been deeply involved in the ISAC, particularly since late last year when the management changes occurred and Mr. Robb was brought on. The focus of that entity is the critical sharing of information and the EEI companies have been fully supportive of moving that organization rapidly forward with the ability to capture information, assess that information and then get that back out so that there can be actionable direction given to mitigate any issue that might be ongoing.

With regards to the ISAC itself, the team that is there is very capable, it's been very efficient in its acceleration of its development and its growth. There's been exceptional sharing across the financial ISAC, telecom

which are very important interconnected agencies.

And so as far as the ISAC goes with regards to the future, we're very comfortable that we have a solid, strategic plan in place. There's a very executable program of action that is moving the ISAC towards a 24/7 operation and the interrelationship between the ISAC and the agencies -- DOE, DHS in particular has significantly improved over time.

That information has continued to accelerate forward as well so we see it as a critical -- critical piece of our defensive majors and our ability to understand what's going on in a very rapidly evolving atmosphere and making sure that if something is happening at one of our other sister utilities, that that information is shared so that we can mitigate those actions across our businesses as well.

COMMISSIONER CHATTERJEE: Thank you, while I've got you I just want to flag one other issue along with my colleague, Commissioner Glick. We've expressed concerns about the cybersecurity oversight and the natural gas interstate pipeline system and whether the requirements for gas pipeline security need to be brought up to par with those of the electric grid.

As an owner of several electric utilities, you've obviously had lots of experience with the NERC CIP standards. Given that experience, do you think a similar

regime for gas pipelines would be effective in helping to prevent cyberattacks?

MR. FEHRMAN: Well fundamentally on the gas system as you've properly pointed out, it's a critical piece of the infrastructure for the electric system and at least at our company and others we consider the NERC standards as a minimum level of performance.

And going above those is really the charge for those of us who operate these systems. And so from my perspective, the NERC CIP standards I felt were very effective in developing a culture of security, a culture of response and essentially driving into place the capabilities to set a foundation for where companies should position their security profiles.

And from there, particularly the ad companies have really moved forward with regards to our security posture. I do think that similar approaches should be made on gas pipelines -- whether or not there needs to be a standard I think is debatable but I certainly believe that a similar focus of security and a culture of defensive postures on gas pipelines is appropriate.

And when we look through our assessments of pipelines, I would say that again the vast majority of operators are already well-beyond what would be a similar CIP standard, but nonetheless I think there is a good

opportunity here for further discussion on that matter.

COMMISSIONER CHATTERJEE: I look forward to having that discussion with you. My final question is for all of the panelists. I want to engage everyone. I noted that a number of you were happy with the progress of the standard's efficiency review.

We've had some other ad hoc efforts to review the standards like the paragraph 81 initiative several years ago. Do we need more regular review process or after this review will we have eliminated most of the low-hanging fruit for efficiencies? And again, I toss that out to anyone that wants to take it.

MR. CLERMONT: Thank you Commissioner for the question. I think, as we've been saying the industry is changing at a rapid pace so I don't think we will ever have a definite set of standards.

And the review we're doing today we are a strong supporter of that review. We believe as I said in my testimony that it will allow industry to focus on what matter most. It will help for compliance, preparation, monitoring and everything.

I think these are efforts that we create when we feel there's a need for some streamlining. And I think it's great. We don't believe we should necessarily have something systematic although we will have -- we will need

something in the future to review our set of standards.

We may have new standards, we may retire standards. We may streamline standards. So definitely the industry will keep moving. The standard set needs to evolve with that and it needs to focus as NERC has been good at on a risk base. So these efforts I think will lay -- will provide great benefits.

I don't think we should have anything more structured than initiatives that we launch whenever we feel there are improvements to be made to the standards.

COMMISSIONER CHATTERJEE: Thank you, Mr. Cashin?

MR. CASHIN: Thank you Mr. Commissioner. We too are very supportive of the standards efficiency review. We think it's a great process and you know, I think it's probably a testament to this Conference in the sense that it was an idea last year but now it's a SER and actually I think the thing I wanted to speak to was maybe Phase 2 which touches on, you know -- the modifications.

And to your question I think that you know, working with those modifications which I think that process is even demonstrating that there's more to it than just modifying the standard, that there are other avenues that can be explored so we're also supportive of that.

But I think also the standard's efficiency review kind of shows the dynamic of industry and NERC working

together. But importantly, I think to that, is you know we also feel that you know, the other piece of the body of standards is the CIP standards and we'd like to see that review go on as well.

But I think importantly as a backdrop to why the standards efficiency reviews have been going on, there's been a standards grading effort that really just kind of came out of the Board's desire to look at the standards and I think that that's a positive effort but I think that this effort probably has shown a little bit more rigor.

And I think that maybe kind of a rinse and repeat with this is not really that bad an idea. I think that this -- it's been a good effort and it showed sort of that there's been an area between paragraph 81 and this effort that needed to be explored.

COMMISSIONER CHATTERJEE: Mr. Schmitt, any thoughts on this or other?

MR. SCHMITT: Sure, thank you Commissioner. With respect to the standards review -- efficiency review, we're supportive of that and we think that's a good direction to go. I think it's important though also not to miss opportunities for either modifications to existing standards or even new standards.

When I think of a particular challenge that we have in California around inverter-based technologies over

the last year or so we've had incidences where the inverters haven't ridden through faults on transmission system and so we're operating in some 1200 megawatts of resource comes off the system and it doesn't return quickly or it doesn't return quickly and then it returns quickly.

So it points to the need for -- we think, some standardization around the configuration of those inverter technologies. There is a standard that exists today that potentially could be modified.

But anyway, the point is to the extent there are clear gaps then we should be mindful of looking after those.

COMMISSIONER CHATTERJEE: Thank you. With that I will file closure on myself and shut-up and yield my available time to all my colleagues, Commissioner LaFleur?

COMMISSIONER LAFLEUR: Thank you. Terrific discussion already, I want to pick up on Neil's last question and some of the comments I made when I opened. And thinking beyond the standards efficiency review, really focus on what's the state of the standards right now. I mean do we have in place a good set of baseline standards with some improvement as we do reviews?

And then as new threats come up and new challenges we attack them with assessments and other tools and when do we decide, given the length of time it takes to formalize something in the standard, get it approved by the

voters and then the Commission -- when do we decide that something is a sufficient challenge that it gets to that stage because clearly we haven't thought of everything already.

And Eric mentioned the inverter -- there's two way things can become a standard -- a system's authorization request as Eric mentioned with the inverter issues in the west which are by no means limited to the west because the technology is used in other places, and/or a directive from the Commission which is usually not met with hosanna's, but we don't do it unless we think there's a place that's been neglected that really needs a standard.

So I want to start with Jim, but give other people a chance to comment. How do you think of that in your own as you look at your tool kit of assessments, alerts, standards, collaboratives, and all the other nouns that factor in the state of the reliability report?

When is it time to move and start trying to work through things?

MR. ROBB: That's a great question and I wish I had a very CRISP answer to that but I don't.

COMMISSIONER LEFLUER: You've got lots of time.

MR. ROBB: Well if you give me lots of time you know I'll take it but I'll try to be brief. No, I think there's a little bit of, "You'll know it when you see it,"

embedded in here. And I think the one thing I would underscore is we should have the goal of having the right set of standards for the industry at the time. We shouldn't have aspirations for more standards or less standards or more requirements, fewer requirements, we should have the right set of requirements and the right set of standards.

COMMISSIONER LAFLEUR: I think we can all agree to that. The goal -- we're not on piecework here, we definitely don't make more if we have more standards.

MR. ROBB: Exactly. I think the -- I think in the case of the standards efficiency review, part of what makes that a powerful process right now is we have lots of experience with the standards. We know which ones are important, which ones, you know, are really driving changes in utility behavior and so on and so forth.

So it's appropriate to step back and look at those. I think the CIP standards, at some level, they're very fresh. I think we need more experience with them before we know whether we need to go through an efficiency review and start dropping out requirements. At the same point in time I think it's very clear that the CIP world and the threats that we're trying to defend against are evolving much more rapidly than we can evolve standards, right, so I very much agree with Mr. Fehrman's comments that the

standards really are meant to set a foundational baseline of performance and not meant to defend against everything because we'll never be able to do that.

I believe that the work that we do around assessments are very good at identifying issues that are coming down the pike and if we have our lenses far enough down the road then that gives us plenty of time to address an issue through a standard. We believe that that's required.

I also think that we're great beneficiaries of what I like to refer to as a learning laboratory in California where we're learning lots about what the changing resource mix that we'll be seeing in other parts of the country means for reliability.

You know the California ISO has been absolutely remarkable in terms of its ability to operate with its constituents and neighbors to deal with a number of very stressful situations on the system. And we need to take a lot of learning out of their experience, the experience of dealing with inverter-based resources.

We are looking at the two SARS that the Cal-ISO submitted and are starting the standards process up around those. The national gas issues surrounding operating flexibility have really crystalized in our minds from the experience in southern California.

So we're learning a lot and I think we need to look at the range of tools, whether it's making things into a standard, providing a guideline to industry to address issues and looking at the assessment work that we do and always asking the question -- is this an issue where a standard would be helpful or are there other tools to get at it?

COMMISSIONER LAFLEUR: I think you've hit on something that's really important which is learning from the lessons of one region. You mentioned CAISO but we also have TRE and MRO, have a tremendous amount of experience with the wind integration, and building on that so we don't repeat the same --

MR. ROBB: Absolutely.

COMMISSIONER LAFLEUR: Issues in other parts of the country that some of the early stage issues came up. And I think the reason I push on standards is I think there's a conservatism built into the ERO fabric because of the industry voting mechanism that a standard means something that can be enforced, means penalties, means FERC, and so that it's kind of not the first tool you pick up, it's pretty deep in the depth chart and part of our job is to be annoying and push when there's something like the inverters or something else that might lend itself, yes.

MR. GALLAGHER: Commissioner, when we ask this

question of ourselves all the time and some of the questions that we ask ourselves along the way is how pervasive is the threat? How imminent is the threat? You know standards are not, in my mind, the ideal way to deal with emerging or potential threats.

They're good as it's been mentioned on this panel a couple of times already to build a foundation and to elevate really minimal expectations. Sometimes the threat or the risk can be addressed quite well outside of the standards process.

And a good example of that is in 2014 when the polar vortex occurred. It particularly hit my footprint hard and in collaboration with the Office of Reliability we set about with an aggressive program to deal with that, to go hands out and to go and do site visits and to take corrective measures working on a voluntary cooperation basis with our generation owners.

If we had gone down the standards path in that case we would not have been prepared for the next winter. Taking this more aggressive, non-standard approach, we were able to elevate the performance along with working with our RTO's and the improvements that they made and the voluntary cooperation of the industry to have much better performance when similar, but not as bad cold weather hit the following year and then again this past winter -- so sometimes

standards are not the best way to deal with emerging threats.

The other aspect of it is -- can we write a meaningful standard that's going to address the tailored risks that we're dealing with? And a great example there is CIP. Oftentimes when we work with companies that have CIP problems, it is organizational structure, its lack of engagement and visibility by the CEO, it's a disassociation between compliance activities and security activities and a lot of other things that really cannot be addressed in the standard.

I don't think any of us would ever presume to tell a multi-operating company, multi-state company how to organize their corporate structure. And sometimes we have to work in a much different way so standards are not always the answer but they're vital and important parts of our tool kit that we depend on.

As far as standard efficiency review, we are all for that. We constantly want to be looking at continuing to improve the tools that we use. It doesn't always mean there's going to be fewer standards though -- it just needs to make sure we have the right standards there doing what they need to do.

COMMISSIONER LAFLEUR: Yes, so you mentioned the time horizon when something's moving very quickly. A

standard isn't the first action but at some point as it recurs it might become part of the new baseline?

MR. GALLAGHER: Yes.

COMMISSIONER LAFLEUR: Sylvain?

MR. CLERMONT: That's a very interesting question. I'm afraid I'm going to answer by asking another question -- what is a standard and what is it for? We've said that it's a baseline or a foundation. Sometimes I refer to those as best practices and I'm going to take a very tier example -- monitoring limits.

We have standards that say that you should monitor your limit, your system operating limits. We all did that but with standards it was a good way to make sure that there's a common foundation on how we do that and --

COMMISSIONER LAFLEUR: A standard way to do it.

MR. CLERMONT: A standard yeah, a standard yeah exactly. So not everything is mature enough or as a large base in the industry enough to be a standard. I like to use cold weather operation -- we had discussion about a standard on cold weather operation.

As I keep saying cold weather operation is called normal operation at Hydro-Quebec. That's what we do every winter. You know, any jokes set aside, for a standard to be effective I think it needs to address a common and large problem, it should not be something too specific.

The other idea is I think standards -- when we considered the idea of a standard we should keep in mind the efficiency and compliance because after a standard is adopted as you know, we will need to comply to that and not even I won't get into the penalty thing but just the compliance, the regular stuff you need to show to -- well to organize yourself, your company to make sure that you do comply. Verify your compliance and then go through the audits and all the mechanism.

So we need to be looking, I think, at what is the most efficient way to make sure that we keep reliability in mind and achieve reliability, understanding that a standard has some drawback to it. So I don't know whether that's useful but I think a few thoughts on the how and when we should use standards and there's other tools as you said, and one tool I always like to remember everyone, is the forums.

The forums -- the NATF and the GATF do an incredible job with entities and it's a bit like Tim described earlier in his first remarks. It's working with people. It's working and making sure we talk to each other, we share practices, I think very important and useful tool.

COMMISSIONER LAFLEUR: Steve?

MR. NAUMANN: Just very quickly to add -- I agree

standards are not always the best solution. They do take time and they take a lot of effort on the part of both NERC and the industry.

I agree with Jim, "You know it when you see it," kind of thing but for a standard it really has to be something that is relatively -- an issue that's relatively stable. It is something that you can write in a way that can be enforced and that you have something that you can measure as to whether you comply or do not comply.

And there are things -- what we're seeing, many of the emerging threats are really one-offs and they're really not the kind of thing that even if you were to issue an order or we were to put it in an SAR, you couldn't get a standard in the time period that you want to remedy the issue.

And so I think guidelines, you know, especially in the security area were -- there's a timeliness, a real timeliness here and whatever you do today is going to change tomorrow because the threat is going to change. You're dealing with intelligent adversaries, but at least we must assume we're dealing with intelligent adversaries so if we close one door they're going to look for another door.

So guidelines, alerts -- I'm glad Sylvain mentioned the forums because they do wonderful work and they can do that through -- also through their non-disclosure

agreements. We can talk to each other.

COMMISSIONER LAFLEUR: I would --

MR. NAUMANN: I'm sorry.

COMMISSIONER LAFLEUR: No, go ahead.

MR. NAUMANN: I just think you have to look at what, you know, can the standard be written and enforced and do you have the time to do it? Is it a long-term issue? The inverters are being recognized now and we're going to live with them.

The threat of the day to the OT systems is taking in fact, research by DOE starting to see how they can do that so that would not be a standard.

COMMISSIONER LAFLEUR: I would just observe a couple things back. One is as you know and I remember, we did all of this or most of this, trim trees, set relays, did planning before the standards were even mandatory.

And the reaction to the whole thing when it started was, "Oh my God, we have to write all this down, this is so annoying." But then that's what the whole standards body is. It is taking good practice and codifying it in a systemic and standardized way.

And I just want to be sure that we don't get stuck with a set of standards that were like there when we did 693, when we started with the body of the grid as it existed then and we went through that huge effort to write

it all down and then that's kind of like what we have now, because that's the time horizon when we did it when so much is changing as we've all referred to.

And I would also say that in the two standards that we've issued directives -- physical security and GMD, in both cases we got back standards that were self-adjusting, just like tree-trimming is self-adjusting where you didn't say, "This is the limit forever," but somehow you set up a system where you go out and check and maybe that's, you know, what we'll see more of.

I know you're pushing the standard right now for inverters.

MR. NEUMANN: Right, and I already mentioned that. I was going to comment on -- it seems to me that reliability has been and really always will be about performance management around metrics. It continues to improvement and maybe that goes without saying.

But I think the core of front line reliability has to happen there and then the standards are really the backstop of those kinds of activities.

COMMISSIONER LAFLEUR: I'll just ask one other question starting with Jim and others from the west. I just wanted to tee out something that Jim mentioned in his pre-filed testimony and his opening remarks which was what's happening with the reliability coordination function

in the west because I want to be sure that we, at this Commission, keep an eye on what the key issues are to sustain all the lessons that Marie and her current team have put in since the 2011 southwest blackout to get the situational awareness and all the things that WECC and PEC and the constitutent companies in the western interconnection work so hard on.

So as we make this transmission from PEC to an unknown number of reliability coordinators that seems to be more than one, what do we have to keep our eye on? What should we be doing?

MR. ROBB: So I think the key thing to remember about the western interconnection and I'll exclude Alberta as a bit of an anomaly relative to the rest of the west is that it really works as one integrated machine and I set Alberta aside because Alberta's really mostly radially connected to kind of the core of the western interconnection.

The -- it's very clear to me and it was clear to me in my role at WECC that having the unified reliability coordinator overseeing that system was very beneficial. One of the issues we deal with in the west is that a problem in the northwest can manifest itself in New Mexico very, very quickly.

So I think the most important thing as we shift

to a multi-reliablity coordinator system in the west that the seams agreements and the operating protocols between them really recreate that entire white area view for the entire interconnection because an issue in the northwest, like I said, will manifest itself elsewhere and if there's not good visibility communications that won't occur.

Some of that is addressed in the standards around information sharing between reliability coordinators. Some of it will be embedded in commercial agreements between the various RC's.

So I think that's the most important thing to keep in mind. I think, you know, we have a very formal role that we'll be playing in terms of certifying the emergent RC's once they declare and we've had a formal request from Cal ISO to go through that process but I don't think we've had the formal request yet from SPP but we anticipate one from them.

It's as yet unknown exactly what BC Hydro will do and the one issue I chatted with Steve Burbridge, at the ISO last week about this -- the most important thing that can happen right now is for the TOP's and the BA's in the west to declare where they're going to go so that we know where the seams are.

We can't really get started on the seams agreements until we know where the seams are and so the most

important thing -- and I applaud PEC and Marie for taking the initiative to try to get clarity around their future so the rest of the industry can plan, but it seems to me that's the most important thing right now is clarity around the topology and then the hard work to get the RCs certified, but most importantly those seams agreements in place for the interoperability of the system.

MR. SCHMITT: Sure thank you Commissioner. I can just build on what Jim said. Indeed the seams issues are going to be top of mind. There's uncertainty around the exact footprint as we move forward we obviously are talking to potential customers and have been engaged with them to shape the service and so on.

Some entities have actually announced recently that they intend to take service from California ISO and they're key locations. For example, Bank -- which is you know, right in the heart of our balancing authority and LADWP -- those two things would obviously make the seams issue with respect to them non-existent if they take service from us.

So we're very cognizant of it. We expect in really the next few weeks to have much more clarity about scope of service and I think more recently we're focused on transition because we think that's absolutely critical as you point out as we go from you know, a single RC in the

west -- multiple RC's in keeping peak is strong as ever and is going to be essential over really all the way through at least 19 -- 2019.

COMMISSIONER LAFLEUR: Well thank you, it is my understanding as Jim said that a lot of people have two dates for the prom right now and before we start buying corsages and renting limos they need to decide who they're going with.

MR. SCHMITT: Exactly people -- the uncertainty is what's not good for the situation.

COMMISSIONER LAFLEUR: Thank you.

COMMISSIONER POWELSON: Thank you Commissioner Chatterjee, Commissioner LaFleur, they could use Uber if they like or Lyft.

You know first of all thank you for your testimony here and I just want to pick up on the CIP standard conversation. It's almost like the question for all of us here is what is the reinsurance policy for the electric power system? And recognizing that one-tenth of our economy is represented here today in the electric power sector and we've talked earlier about these weather related events and I can belly up to the bar here that you know, I was at the helm when the polar vortex hit.

And so here are some analytics and I want to throw these analytics out there so we can have a

conversation about what that reinsurance policy looks like. So in PJM we had something like a 23% forced outage rate -- meaning powerplants that had capacity obligations that were supposed to provide power to the grid didn't make it on January 6th and 7th of 2014.

By the way, the fact that I remember those two days -- January 6th was my birthday, so a nice birthday present as a Chairman of a state public utility commission. So lessons -- I heard it earlier, we learned a lot of lessons and the market in the case of PJM and New England developed products like capacity performance and other metrics to kind of drive and we'll say cleanse the market, so that going forward -- again, going back to the concept of our reinsurance policy in the market so that this event would not happen again or we call it the now N minus 1 minus 100% calculation that we have now, the evolution of dual fuel capabilities in certain markets.

So I want to -- I just want to throw that out as, you know, here we are today. We've had a lot of changes in our power mix and you have all eluded to. You know we talked earlier about the integration -- and Jim I want to comment you although you weren't there for it. There's a great report that was done by NERC on the integration of DER's and the impact it's going to have.

We recognized that last year in our U.S. bulk

power system that 10% of our energy dispatch came from renewable energy. I've said it once, I'll say it again -- you don't have to have an MBA from the Wharton Business School to understand that that 10% is probably going to grow to 15 to 20% over the next decade and I comment my good friends at Berkshire Hathaway -- we are part of the family in my side. Patrick you know that -- that the work that you're doing around renewable investment and how important it is.

And then you couple that with the efforts done by this Commission to recognize energy storage and you have added disruption on the horizon to the bulk power system. So I want to tee it up kind of as a macro thought for the panel. Tell me or tell my colleagues and I what that reinsurance policy should look like going forward.

And again, I think it starts with a baseline. I heard it with the CIP standards, but what in your view, if you were energy tsar for a day -- we don't have all day do we Commissioner Chatterjee?

What would that look like? And how do we do it in a way, as I learned from my EPRI experience from the prism, affordability, reliability and that baseline of environmental sustainability -- how do we accomplish that goal recognizing that we've done -- I want to pick up on one of the panelists.

You guys are doing boring pretty good right now. We're seeing strong reserve margins, the grid's getting cleaner, it's getting more efficient. My good friends in Mexico, the great story on how competition policy has driven positive outcomes in our bulk power system. So I want to tee that up for you. What does that -- I'll say it -- reinsurance policy look like for our bulk power system over the next 5 to 10 years?

And at what cost should it come to consumers -- Steve?

MR. NOUMANN: That is the question. And I think you start with trying to understand where we will be in 5 to 10 years. And that's difficult -- in my pre-filed testimony I gave an example of if you want to send a probe to Jupiter you don't aim where it's today -- you aim where it's going to be.

The problem is we actually know that and this is more difficult, we don't know. We need to do the engineering. We need to go through scenario analysis and people may not like some of the scenarios, they may say they're too severe.

You know what? That's okay because you don't have to act on it. You need to go through a robust scenario analysis for all types of hazards. Do the engineering, cite what are the consequences if A, B, or C happens. Now you

have the consequences, you can assign probabilities.

You could say what are the -- what would be the remedies and how much do they cost? But the basic thing is doing the studies to have the information to make those policy decisions. It's made more difficult as you say by emerging threats that we don't really -- if we sat here five years ago, right and we said we're going to be worried about a nation state attacking our operational technologies, well maybe some people who had some access to classified information might have said that's a problem, but I don't think we would be having that conversation.

So that's why I'm saying look at a robust set of scenarios, do the engineering on some of that -- and we've eluded to this, we really do need the help of other agencies who do have access to information to do -- to try to do what's called the design basis threat, to at least give some kind of baseline of are we being ridiculous in these scenarios or are they reasonable scenarios or reasonably extreme scenarios to study.

And the other thing that's going to make it harder is the interdependencies. We really need to understand those because there are things that kind of sneak in. So for example, you mentioned dual fuel capability work that's been done. That's great up until -- and I'm not -- I'm giving this as an example not saying

it's going to happen.

You need to resupply the fuel and everybody needs to resupply the fuel that's been burned and the roads are clogged. And I guess I'm a little older than most of the panel. I do remember the '65 blackout. I was in an elevator in Brooklyn, New York, but I was also -- during the huge snows in Chicago and the cold in '77-'78, '78-'79, where they were worried about getting food into the city let alone fuel.

And so we have to go through each piece of those in the scenarios. Once we do that and that will take time, it will take very, very smart people. I think then we can have the conversation as to what to do, but I think the policy makers really need to be informed with a robust set of analyses.

COMMISSIONER POWELSON: Anything else Jim?

MR. ROBB: Yeah, I'd like to build on Steve's comments because I think they're spot on. I think the one challenging thing we have in the industry is we don't have a uniform industry structure around the country.

And you know one of the questions or one of the issues is that as you look at inter-dependencies we typically naturally go to the inter-dependencies across sectors but just inter-dependencies with neighboring utilities.

It's hard to do this analysis on a simple utility system because many of the solutions will turn out to involve regional cooperation. I'll cite some work that WECC did around kind of the natural gas vulnerabilities associated with the pipelines in the west.

If we didn't integrate the models between a pipeline disruption and how the electric system would respond and be dispatched across the entire interconnection, we would have come to very different conclusions.

You know, we did find a few hot spots where we didn't think that the electric industry could fully compensate for the loss of a pipeline. But for the most part the electric system because it has so much redundency, so much resiliency to it can. So you really got to be able to look at something on the right geographic basis as well as the right set of sectors to deal with.

I think it's a real issue in the west, not having any -- well WECC fills that role in the west of being able to do interconnection-wide studies. But in the southeast, for example where you don't have an RTO, there's not a natural agency to do that broader picture, and I think that's something that is well worth considering, you know, having an entity that can do -- identify the stress scenarios and the stress scenarios will be different

region-to-region-to region, right?

So it needs to be thought through in a way that they can identify the appropriate stresses on their system and then what the suite of mitigtion options are if indeed you find a risk that is unacceptable to wear.

I think it's also important to use the reinsurance analogy Commissioners, that it's important to have your eyes open to the risks but also recognize that some of you may choose to wear and not mitigate because the cost of mitigation relative to the likelihood of the risk manifesting itself doesn't work, but you have got to have your eyes open to that, you don't want to be, you know, caught by surprise.

And so that's what I think doing the analytics, getting the right scope of the analytics -- both geographically as well as you know, what sectors you include is very, very important.

COMMISSIONER POWELSON: Thank you, Tim?

MR. GALLAGHER: So as a power system engineer this is the kind of stuff that excites me Commissioner because it does truly become an engineering problem. And I think it's inevitable that there's going to be a drastic change in our resource mix as we move forward.

The only other comment I would make in addition to what Jim and Steve said is -- in addition to looking into

the future, what does it look like, how are we going to operate it? I would ask all of us to think about how are we going to protect it. Security cannot be a condiment that we sprinkle on things after the cake is baked.

It's far better and more efficient, more effective and more economical to put it in at the beginning. So I look at this as a tremendous opportunity. As this changes, we can now as it's changing and before our eyes, we can start to put in the protections we need to at the grass roots.

So we have a tremendous engineering opportunity and security opportunity in front of us, thank you.

COMMISSIONER POWELSON: Well said. Anybody else? Am I okay on time Commissioner? Should I invoke cloture on myself? I'm going to go with one final question. So you know I was just reading a report on my train ride down this morning and so here we are today in Pennsylvania. I can't say anything without starting with Pennsylvania, home of the Philadelphia Eagles by the way.

We got food last night at the Boston -- we lost 2-1 to Boston, I was waiting for my colleague to rub it in, but 13 innings. That being said, so here we are -- gas demand from 2007 to 2017 grew nationally by about 19 %.

In my home state gas demand from the electric power sector increased 250% meaning we ain't building

nuclear plants. We're not building coal plants, we're building a lot of state-of-the-art gas plants with probably 6,000 heat rates and there's a report that Jim again -- before your time that addressed the lack of pipeline infrastructure in and around the greater Pittsburgh region.

I have grave concerns with reports that before your time that were put out making accusations in this narrative of the grid's not safe, that the greater Pittsburgh region where there's been more Marcellus gathering -- and let me just share with this group just to give the magnitude of pipeline development in my home state.

From 2007 -- between the time period of 2007 and 2017 Pennsylvania saw more proposals in front of the Federal Energy Regulatory Commission -- that's 53 applications, nearly double the amount of the second highest state, New York, which has absolutely done nothing to build pipeline capacity.

These 53 projects approved between that time period represented about 13 million cubic feet of new capacity into the market and about 7200 of additional pipeline capacity. Now not all these projects got approved, but my point is the analytics do not jive with what NERC put out on the street.

And I can go back to the Pennsylvania Public

Utility Commission that registers all the new pipeline that has to be registered for safety inspection and that number is up to about 3,000 plus miles of new gathering system built. So I just want to share that with you because I think we got caught up -- if I can use the word lightly, the political vortex of Washington.

We're trying -- we want to keep NERC away from the fringes of using a political narrative to drive an outcome. And I applaud you because you hit the ground early with all of us in kind of saying, "Hey, I'm the new guy. We're going to stay down the course of doing the analytics and staying outside the political fray before assessments are made."

And I applaud you there. I'm going to cast off in another role here shortly but I just want to continue to applaud you for staying down the middle and staying away from the fuel wars that seem to dominate this town. You don't have to comment on that -- that's a Philadelphian's way of saying a nice shout out.

MR. ROBB: Well I appreciate that and I think and I've made this point in the interviewing with the NERC Trustees and I've said this many, many times. NERC needs to be the technical conscious of the industry. We don't need to be the political employee of any particular interest. So it's certainly a very high priority of mine that we stay

ideologically independent around these issues and really deal with the technical issues on the merits of driving reliable systems, so I appreciate that.

COMMISSIONER POWELSON: Thank you and lastly, Commissioner Chatterjee, this is shameless self promotion but we talk about electric and gas. I'd like to see the water sector engaged in this conversation for all the right reasons. We lose water systems in this country we can't cool power plants and run power plants for that matter.

And anybody who's participating as my good friend Joe McCullen has done a black sky event where you realize that with 4 maybe 5 days of water supply with diesel backed up generation, the cascading events when those systems go down -- and I just -- I would like to invoke a little executive privilege here that you would include my new endeavor as part of that conversation, thank you.

COMMISSIONER GLICK: Thanks Commissioner Chatterjee I appreciate the remarks. I want to start with the reliability RC, the reliability coordinator issue in the west. Obviously that's gotten a lot of attention. Commissioner LaFleur mentioned it earlier and I wanted to start with Mr. Schmitt if that's okay.

I -- some of the concerns -- I've heard some concerns from a few of the entities out west -- the non-California entities that if the California ISO does

become the RC which it appears or NRC which it appears highly likely, that given some of the governance issues that the California ISO is both in terms of operating in the market and also being the RC that there may be some potential conflicts of interest.

And I was curious how you all intend to structure your governance of the RC to address that issue?

MR. SCHMITT: Yes, thank you for that question Commissioner. We separate the broader discussion around California's legislative decision around over-arching governance for the California ISO.

The RC services are, as you know, driven by the compliance standards, their operational engineering in nature and in that regard we brought the folks -- the potential customers in the western interconnect that are responsible for reliability to the table to actually create the framework around oversight.

And we've done that over the last three or four months and adopted it as a framework. So we think it honors the independence and separation between our reliability function -- our BA reliability function and markets and RC services.

Organizationally and process-wise we're creating the kind of separation that you -- customers would like to see and yes, there's more, you know, discussion to be had

around that as we go forward we think though it's a good start to answer and address the questions that you cite.

COMMISSIONER GLICK: Thanks. So turning to Mr. Robb on a relatively similar issue. So Peak -- I know Peak announced just recently that it was going to cease operations at the end of 2019 and that doesn't give everyone a lot of time. As you mentioned people still haven't -- you know, a lot of people haven't chosen their dance partners yet and there's a lot that has to be done in between.

I was curious what NERC and WECC are going to be doing to help just expedite the process?

MR. ROBB: We sent a letter to all of the -- first of all I will say that the senior leadership of the TOP's are well aware of this issue and very concerned, very committed to having a good reliability coordination function in the west. I think that's a fair statement that I think everyone is on this issue.

We sent a letter jointly between NERC and WECC asking all of them to identify the reliabity coordinator they intend to go with by the end of the first week of September. Now we don't necessarily have the authority to compel them to do that, but have asked them to do that and I believe we'll get a pretty good response to that.

Melanie recently appointed CEO -- she and I have

talked about sending a follow-up letter now that the Peak situation has clarified to reinforce the importance of turning all of these non-binding irrevocable agreements into really hard contracts so that we can do the work. And I believe the industry will do their best to comply with that.

MR. SCHMITT: Commissioner, maybe I could add to that. We're prepared and we have been really from the beginning of our initiative in January. We've been preparing to take any and all customers in the western interconnect. So in terms of scale and timelines we're confident that we can handle whatever scope there is in the west for RC services.

COMMISSIONER GLICK: Just to follow-up on that, you mentioned it was discussed earlier the possibility that SPP's going to come in and claim someone. Is there a possibility of retaining, having a single -- there are benefits of having a single RC in the region. Is there a possibility that all the entities in the region might come together and agree to continue as one RC -- it might be under a different name, or maybe the ISO or somebody else?

MR. SCHMITT: I think it's possible. I think transition though may -- we may see combinations as we evolve and migrate but it's very possible that that could happen in my view.

COMMISSIONER GLICK: I wanted to turn to an issue

that's been referenced a couple times but I'm trying to get up to speed on it and that's this inverter issue that NERC has pointed out as one of the key priority areas going forward. I'm just wondering, Mr. Robb if you can explain the issue in a little greater detail and what NERC is suggesting to address the issue and maybe then Mr. Schmitt you might talk about what the ISO has been proposing with regard to the inverter issue.

MR. ROBB: I'll take a stab at that but Eric could probably give you a more on the ground description of the -- of the technical issues in play. But effectively what has happened is inverters have many smart capabilities built into them but nobody ever told the inverter owners how to program them and what performance characteristics they needed to have.

One of the issues we've always been concerned about and manifested itself in August of 2015 was that in the course of an event that inverters would start to act in tandem and that they would actually elect to protect the equipment more than protect the grid because there was never any guidance as to what they needed to do to protect the grid.

So the first event we saw was the blue cut fire down in southern California and we lost I believe almost 1200 megawatts at the same time. That put us into the issue

around how inverters detect frequency and the interesting thing to us was that they don't actually measure frequency, they calculate it.

They all calculated it differently and they all -- so they all started to behave inappropriately and again a loss of 1200 megawatts is a substantial event, particularly on a hot day in the summer in California.

We issued a NERC alert around that with guidences with how the inverters should be reconfigured. That work was done jointly with WECC, the CALISO, a number of inverter manufacturers and facility developers -- a great collaboration of industry in the North American general forum was involved.

So we thought we had that issue solved and then last summer we had another fire and discovered another issue surrounding when the inject power and when they don't, alright so another solution has come out.

So it's been a little bit of a journey of discovery. The issue that we were aware of could happen but had never manifested itself so we could study it. And I think the good news here is that industry has been very responsive -- extraordinarily collaborative at working with us and various principals to solve this issue.

And you know, do I think we have it solved right now? I think we've solved the problems that we know of

right? We may find another one, right? And we'll continue to work on that and then I think the two SAR's that CALISO have submitted have passed our screen of having technical merit to turn into a standard.

So our standard's committee will start that process I believe in August of signing the drafting team and starting to work on that. So that's how this appears to me but I'm sure Eric could probably refine that significantly.

MS. SCHMITT: Yeah, I don't know Jim you did a pretty good job. I don't know that I can add much. I think one thing that became evident early on was around communication. So the willingness of manufacterers and providers has been there. Once the events happened -- and so compliments to those groups and just understanding the limitations -- excuse me, not the limitations of the inverter, but the way they are configured given the environment they are operating in.

The capabilities are there so I think helping the industry understand where we were and then now standardizing those configurations so that they behave -- that they're protected but that they behave consistent with operating the bulk electric system.

And we have 11,000 megawatts of solar resources on our system, 5,000 megawatts of wind, 6,000 megawatts of rooftop solar and in the shorter months we routinely run 40

to 60% renewables on the system in the middle of the day.

So we need those -- we need those inverter-based resources to behave at their very best.

MR. ROBB: I'd like to make one other point if I could Commissioner. One of the challenges in this area is that California is relatively unique in many ways but in this case, because many of these large solar farms are connected to the high-voltage electric system -- that's not always the case.

For instance in North Carolina, a substantial amount of utility-scale solar is sub BES level, BPS level and therefore not within our jurisdiction. So a couple things that need to happen -- one, and we've been pretty deliberate about this making sure that state Commissions that do have jurisdiction over other resources are well aware of the work and you know, adopting or at least considered putting in place similar guidelines.

There's also some work that has been catalyzed in IEEE to deal with these issues as well and that's a great way at getting at the non-NERC jurisdictional assets that still have these same capabilities to play more nicely with the system -- so a couple other initiatives underway that are important here.

COMMISSIONER GLICK: That's very helpful, that's a good explanation. Turning to Mr. Cashin for a second and

I don't that APPA is a pretty bright organization, they have a lot of different members -- some of them are very big municipal utilities -- Seattle, Austin, Los Angeles and so on, but you have a lot of small entities as well as NRC -- NRECA's in a similar position.

And with regard to cybersecurity I know that in your statement highlighted the recommendation in 2008 state of reliability report that reliability and improved notification capabilities by the EI SAC to APA member companies. I was wondering if you could expand on that.

How can the APA member companies, especially the small ones, receive better information from you guys and I'm curious if the financial issues are a significant barrier to that?

MR. CASHIN: Well I think just to begin yes, the financial issues are a barrier but I'll play off of maybe the last comments here a little bit. You know, one of the things that came out of one of the -- at the last Board meeting was that a lot of solar facilities that you know, would be affected by the alert were non-BES and some of those actually were our members.

So they were influenced by that but that was just it is one of the rewarding aspects from my perspective of that was the simple fact that these folks while one -- they were communicating with me so they knew about the alert.

Also, they were very -- they were participating in the ISAC so as a non-registered entities if you will, they were in much adherence to the ISAC and it's information so, that's a good note there.

But in terms of you know, trying to take advantage of that, I mean you were very supportive of -- you know we think of the ISAC in its infancy and that it's you know, really growing and we're happy to see say for example, you know, the budget increase that's happening this year and we'll go forward to bolster the ISAC because clearly, you know, that's a big piece of it is that informational flow because companies, you know, have really felt that you know, they are acting on threats and vulnerabilities that they know about.

And certainly if there are ones that they do not know about and need to be communicated to them, they need to find that out.

COMMISSIONER GLICK: So I know that the Department of Energy has been working with you all and others, only for small and medium-size utilities in terms of a project really aimed at helping those utilities improve their cybersecurity. I was wondering if you could expand on that a little bit -- what DOE is doing, how you're working with them and if that's working.

MR. CASHIN: Sure, I appreciate the question

Commissioner and it's our SED's project and you know, in many ways I think a lot of the companies looked at some of the programs that were out there when they looked at MIST, when they looked at other forms of identifying your company or trying to evaluate it -- is that they felt the size of the questions and so on and the scale didn't necessarily fit.

So there was a need to reach out to DOE, get the SED's program going and this gives companies the opportunity to really kind of right size their programs. And, you know, one thing just as an incidental sort of point along those line is that you know, I found we did a white paper on supply chain with NRECA, and you know, a lot of what we found with the smaller companies is that you know, one of the hurdles that I think some of the larger companies have -- they don't have and that's communication across lines is that you know, rather than looking for somebody on a different floor, you're looking for somebody who is right down the hallway from you.

So that's been a big piece of enhancing that communication within companies on the cyber frame.

COMMISSIONER GLICK: Just one other question to finish up and I know that earlier Commissioner Chatterjee mentioned and Mr. Ferhrman answered the question regarding the cybersecurity of our natural gas pipeline system and if

we needed mandatory standards or not.

I think a similar issue relates to the regulation of cybersecurity on natural gas pipelines which currently occurs at the TSA and the TSA -- I mean they do a great job at the airports and elsewhere. I think there's been some question about whether they have the resources in terms of human resources -- they only have six people that are really focused I think on this issue with regard to all the millions of pipelines across the country -- not just gas but oil as well.

And so I think we need to take a look at that further, but I'm curious -- starting with Mr. Robb and if any others want to weigh in as well, whether you think there is cybersecurity -- an increased cybersecurity concern with regard to our natural gas pipeline system and if you think a similar effort that we have for the electric utility system in terms of these minimum standards and so on is something we need to apply to the gas system as well?

MR. ROBB: My answer to this question will be unfortunately more speculative because I don't have nearly as much visibility into the mechanics of how the pipeline systems actually operate. There is a big difference between the pipelines and the electric sector though that's important to keep in mind and that's the fact that in the electric sector when an event happens it propagates so

quickly whereas you know, natural gas moves at I think 37 miles per hour right -- so it's a completely different reliability related issue.

Now do I believe that there's a security threat for the pipelines? Absolutely, they're a very critical part of the electric infrastructure and need to be protected. I'm not in a position to say whether or not the TSA standards or approach is adequate or not. I would share the concern that you've raised.

I will say one thing that we have done with the ISAC is that we have a natural gas ISAC employee embedded with the electric ISAC so at least we have that opportunity for cross sector communications.

I suspect that's woefully insufficent at this point. So I think it's a great question but I'm not able to answer it competently and completely.

COMMISSIONER GLICK: Does anyone else have any thoughts?

MR. CASHIN: No, I mean nobody wants to have mandatory standards if they can avoid it. I understand that. I think what makes this difficult as you say is there is a split of jurisdiction. This Commission cannot do this under their authority. Maybe you can do something when you site a pipeline.

But I think looking down the road and saying, you

know, what could be the vulnerabilities and how could they affect the bulk power system. I think this Commission has to -- can work with the other regulatory agencies -- TSA, and getting the input from people who actually can tell you what the threat might be.

I mean we're sitting here and everyone knows there was this sensational report in the Wall Street Journal last week about what specific nation state has been or allegedly has been doing which the electric industry, through the ISAC, through the SCC, through our government partners has known about.

So I do think you need to have this different conversation both with DOE, with TSA, with this Commission, with NERC and with the gas industry about how to get that door protected becaue I know it's an old adage but if you're a burgler you're going to go to the easy target.

And if we're spending all this money, all this time, all this effort on protecting the cyber health of the electric system and then you can attack a gas system, a water system, or the railroad system, or any of the systems that -- the communication system that are necessary then we're still vulnerable.

So I think you need a different model here and those conversations should start sooner rather than later because as you -- Commission Powelson has said, the trend is

you're going to have more natural gas, you're going to be more dependent on that and if there's some event we haven't thought about today that all of a sudden can happen and now we're very vuljnerable, that would not be strategically in effect, thank you.

COMMISSIONER CHATTERJEE: Thank you for that, thank you all the panelists for an outstanding discussion today. I appreciate Commissioner Glick asking that final question and your candid and cautious answers. I will warn you in advance, both Commissioner Glick and I have been subjected to additional screening every time we've flown since our op-ed so.

But anyway, we've gone a few minutes over and so in an effort to keep us on schedule I'm going to unfortunately truncate the break to 10 minutes, so we will reconvene in the next panel at 11 a.m., but thank you again, all of you.

(Break 10:49 a.m. - 11:09 a.m.)

PANEL II: Advancing Reliability and Resilience of the Grid

COMMISSIONER CHATTERJEE: Alright to start the Second Panel of the day on the important topic of grid resilience and again we have another distinguished group here and thank you all for your participation and for your statements. My other colleagues will be here momentarily and if they get held up Commissioner Powelson

and I each have 45 minutes.

But again thank you all for your thoughtful submissions and for your participation today. I am going to go ahead and just jump right in with the questions. I will start with Ms. Silverstein, great to see you. Thank you again for your submission here today. I thought one of the important points that you made is that we, as a collective industry don't have clear benchmarks as to what constitutes an acceptable level of resilience.

While I respect that we may have more work to do in this area, I do feel strongly that there have been a lot of changes in the grid so we need to keep the ball moving forward on this. So my question is -- is there work that we can do to better understand what an adequate level of reliability is with respect to resilience without getting bogged down into paralysis by analysis?

MS. SILVERSTEIN: Well thanks for the softball question. I think you need to start by understanding what you want resilience to be. And as my testimony makes clear, I think that it is fundamentally not just about the ability to bounce back but also about the things that prevent outages and the things that help you recover quickly from outages.

I'm not sure what is adequate from the point of view if the grid is very different than what is adequate

from the point of view of the customers. And I don't know that we have within this industry done the right kind of studies yet to determine what adequate resilience looks like in part because we don't yet understand.

I don't think we have all the right tools in place and we don't have very good data on a lot of stuff. NERC has a ton of data about the bulk power system. They don't do as much analysis on the near misses as they do -- they do a superb job on the "what has gone wrong" and what can we do to avoid that.

And the industry's performance in improvement certainly bears testimony to the effectiveness of that analysis and approach. A lot of what we have done though is look at this in the rearview mirror and the world is changing so quickly that the things that we need to be resilient about are changing faster than our analysis and our analytical tools and our scenario designs.

And so I think we need to better understand what the magnitude and breadth of all of those threats are before we can say this is what is adequate.

COMMISSIONER CHATTERJEE: Thank you for that. Along those lines Mark, I appreciated the resilience framework developed by the reliability issue steering committee. It was included in your testimony. I thought it provided a helpful visual with respect to robustness. One

potential contingency that is currently not planned for but is getting more attention is contingencies on the natural gas pipeline system. I know some regions are undertaking ad hoc studies.

ISO New England is obviously a prime example but do you think it would be helpful for planners to look at those risks in a more coordinated way?

MR. LAUBY: Thank you for your question and the answer is yes. We just had a workshop recently on July 10th which was responding to two major recommendations -- one that came out of the long-term reliability assessment, the other one that came out of the gas centered induce study which the view was that we need to re-evaluate or evaluate standards when it came to the potential impacts to reliability from this inter-dependency.

And what came out of that workshop I would say came to two things. One was -- we need to understand what are the contingencies that is the contingencies on gas pipeline beyond just guillotine guts but also, you know, compressor stations or just unavailability of gas because we're on a peak -- a gas peak.

And what are the implications of those contingencies on the bulk power system? So, as taking it much like what you look at electric power systems N minus 1 you know, maybe a line on the ground false start breaker,

what are the consequences that we're not willing to accept that will withstand, similarly for the gas contingencies?

The second was what are the criteria? What are we willing to withstand?

So coming out of that meeting which was held by the planning and operating committee, they're going to be bringing forward some recommendations to the Board which maybe or taking into account potentially looking at the tool box and looking at guidelines, but also start thinking about it I think from, you know, the standard implications especially start looking at TPL1.

And you heard the CEO of NERC talk about this and potentially you know, consistent studies insuring that the people do study them and understanding what the corrective action plans are in place to make sure we get to those kind of criteria.

COMMISSIONER CHATTERJEE: I'd love others to weigh in on this if you have any thoughts?

MR. BRANDIEN: I might as well jump in. You referenced the work that we've done in New England to try to gauge our risk around fuel security and we've even thought about changing it from fuel security to energy security because it's really do we have enough energy to follow the load up and down and to have the reserves so the solar, the energy efficiency, demand response, the wind -- all those

things, imports from neighboring areas all play into that.

So we embarked on doing our fuel security study probably a couple of years ago, now a year and a half ago. And, you know, we questioned ourselves exactly how should we do, what scenarios should we study and what is the pass/fail in that?

We looked through the NERC reliability standards and the TPL standards have some criteria contingency, loss of gas to a gas-fired station.

If I looked at that -- that was less than the operating reserves that I carry in the system so that really didn't uncover.

So we looked at from an energy profile over the winter period and tried to maintain our operating reserves because that was a criteria within the NERC reliability standards.

It would be helpful for us if there was some sort of guideline or something agreed upon on the industry how to look at energy, security and what our the attributes or what is the pass/fair criteria that you should be looking at?

We have spent hours with our stakeholders debating whether or not the approach we use is the proper approach. We think it has framed up the risk that we see in New England but something from the industry, I think would be very helpful.

COMMISSIONER CHATTERJEE: Bob?

MR. BRADISH: Just some recent practical experience with changing fuel supply -- so we went through a period where we had a significant amount of generation retirements. And so when you have rapid changes to the fuel supply or generation supply to the grid, you end up creating changes and flow patterns that may end up requiring enhancements to the grid.

So whether it's a planned shutdown of a generating unit or maybe in this situation an unplanned shutdown of major gas pipelines that shut off a significant amount of generation, you're going to have similar impacts. So we invested, you know, I don't know a billion and a half dollars in new transmission just to handle the retirements that we had in and around the PJM area itself.

COMMISSIONER CHATTERJEE: Competitive transmission?

MR. BRADISH: This wasn't because it was -- it was, you know 90 day notice to retire right, and so when you did the analysis you were already in trouble so there was found to that, you know,
less than three year thing and so we were running fast to build a lot of new transmission to accommodate the retirements that all kind of came at one time.

So yeah I think -- I mean the transmission system there right has surface and syncs, and you have major

changes in either of those. You have an issue you have to deal with on a transmission system so anywhere where you're going to get major changes in those two pieces you've got to do some analysis and you've got to be thinking about that so yeah having some type of analysis for looking -- it looks at possibilities there it would be extremely helpful.

COMMISSIONER CHATTERJEE: Peter, coming back to you -- you noted there are no standards or best practices for how to look at fuel security. What do you think would be the best way to develop those types of best practices? Is it moving forward on a region by region basis, or would some type of facilitation at the national level be helpful?

MR. BRANDIEN: I think first Mark referenced the Technical Conference that they had earlier in July. That took a lot of the recommendations that are out there on various NERC reports and coming back with recommendations. And I was on one of those panels in the NERC Operating Committee Plan Committee which ran it that some sort of national guideline standard would be helpful.

So I think that that probably started the dialogue on whether or not we need to go in that direction. Secondarily, West Yeomans, sitting to my right and Mike Bryson of PJM, we actually have a conference call tomorrow afternoon really to discuss how we're each looking at fuel security, what are the criteria that each of us are going

after, trying to insure we're talking common language when we're saying things and learning from each other what did New England do?

How did we look at -- how did we perform the study? You know, PJM what are you looking at? How are you doing it? How are you going to perform the study from New York -- the same sort of thing. And maybe we could bring forward some of our experiences into the work that NERC is doing and begin to move this forward.

COMMISSIONER CHATTERJEE: And Wes I had a great visit to Albany where we you know, really thoughtfully went through some of these issues. Could you kind of elaborate on the work you're doing in New York?

MR. YEOMANS: Yeah, first of all on your earlier question -- I think there are some subsets of disruptive interruptions that are highly impactful are consistent across the United States. It could be cyber, hacking up fire walls, physical security -- I think there is a large subset that are similar across the nation and then there's another subset that just might be more regional in nature -- maybe loss of gas storage is the most impactful, disruptive event in southern California but that would not be the case in the northeast, but vice-versa loss of a gas line or some other contingencies would be the most disruptive events.

So I do believe even in some parts of the

northeast, I mean just 30-day max averaging events are more disruptive and more constraining than some other physical types of things, but as Peter said we're going to try to work on what are some consistency in these disruptive events, whether we're looking at a gas pipeline.

Do you look at it all winter? Do you look at it out one day or do you look at loss of three? I really like the comment this morning from the earlier panel that we really should be comfortable looking at extreme scenarios -- it doesn't mean we have to do something with it in the end, but we can inform what is the impact and what are the costs and then talk about what the solutions are going forward with that.

COMMISSIONER CHATTERJEE: Others want to weigh in or thoughts on this?

MS. SILVERSTEIN: Thank you, I agree with everything that has been said but I want to point out that many of the disruptions that occur have common consequences regardless of the thing that caused it.

If you have particularly weather related issues often caused major loss -- destruction of transmission events and/or distribution events and we need to be -- and the restoration process is common across many of these events and the repair process is common across many of these events.

And I think it's important that we not just get too focused on what is the cause of these problems but spend a lot more time working on the common consequences and the common methods and processes to recover from that as well as to protect against them.

Because if you are the transmission system you probably don't care if it's a flood or a night storm that's taking you down, if you are the control system it probably doesn't matter whether it is the communications network or a cyberattack inside some stuff that takes it down -- what matters is the consequences and the recovery process.

So yes, we need to prepare against and anticipate particular threats but we also need to get really good at or even better than we already are at recovering from common consequences regardless of the cost.

COMMISSIONER CHATTERJEE: Do you think that focus should be exclusive to T&D or do we need to work at the generator side of the equation as well?

MS. SILVERSTEIN: We can look at the generator side of the equation. It is rare that a loss of generation causes major outages as my testimony points out and as NERC's analysis consistently show, most of the outages that occur and most of the major events that occur have always been due to transmission failures and/or to weather events that cause transmission problems or to human factors, not

because of the loss of generation. That's a very rare circumstance.

COMMISSIONER CHATTERJEE: But you do agree that as we undergo this transition in our generation mix that the analysis needs to be done.

MS. SILVERSTEIN: Oh, of course. Yes, because absolutely the future conditions that we are working on and the future resource mix are going to be so significantly different that we do need to understand that and the kinds of work that's being done on inverter connected resources for instance, is absolutely crucial.

MR. GALLOWAY: I would if I may, just kind of add in very briefly. I agree with Alison's comments. I don't think it's an either/or situation. I think to the earlier panelist's comments on design basis threat, we really have to kind of look at the science around some of these acute issues, especially ones that are evolving so we better understand them and can deploy effective mitigations.

But in parallel there's a lot of stuff that we can do that's a "no regrets" type of work and Alison eluded to that as well. So you can harden a system in ways that are sensible for the known hazards you have right?

If you are in a hurricane prone area certainly hardening the system for that but taking into account other potential prospective threats at the same time is

beneficial. And then there's a universal having affective restoration mechanisms is a no-regrets type of thing that would be helpful.

COMMISSIONER CHATTERJEE: I noted that in a lot of your testimony this focus on all hazards planning and no regrets solutions and it would provide benefits across multiple hazards and I'd just be curious to hear others on the panel's views on this.

MR. YEOMANS: Yeah, Wes from the New York ISO. Yeah, I like that comment -- no regrets. In New York we're doing a lot of things that I would categorize as improving the future resiliency and it is no regrets because we'd be doing these anyways and these will improve reliability no matter how the future plays out but it includes improving our planning processes on the front end, improvements to our economic transmission planning process, evaluating and improving our public policy transmission enhancements.

We're developing energy storage. As you know -- as we all are, we're evaluating current ancillary service products and evaluating new ancillary services like ramping products -- all of these will create some headroom for a changing electric system -- re-evaluating our shortage pricing, evaluating resource performance enhancements for capacity suppliers today and how they perform in tight conditions.

Measurement of capacity performance -- yeah, during critical time periods, evaluating, developing eligibility performance of external light cap, but really similar to PJM and New England we're embarking with our stakeholders a resiliency study where we'll look going forward what we think you know the world's going to look like in New York the next 5 to 10 years, what are the new -- or maybe similar disruptive events and then where are the gaps in reliability?

What are the impacts? What are the costs? And then work with our stakeholders on solutions going forward to those.

MR. BRADISH: So also on the "no regrets" piece, certainly a fan of that. We've done some work in that area and we've actually hardened some of our facilities and we've come up with the ways to harden our facility so it's actually more cost-effective than the traditional way of actually building the facility.

So there are certainly opportunities out there for no regret situations where you can make changes to your grid and you can do it in a cost effective way and add in the additional protections that are required. So I think we need to continue to look for those opportunities because I think they're out there.

COMMISSIONER CHATTERJEE: I appreciate the work

you all are doing, I'm just curious for the panel -- are there no regrets actions that we could take within this Commission's jurisdiction that you all would suggest -- Carol?

MS. CHINN: Well I think we're doing it today. Forums such as this as far as the discussion and debate -- especially on issues that -- I mean the resilience issue has really grown, it's so broad and there are regional aspects to it. Clearly, it's not consistent across the nation. So I think the discussion, the dialogue, the proceeding that you put together and the thousands of pages of information that came back are no regrets.

I think we're all learning from that and we need to coalesce around okay what are those key issues, what are those priorities but I really do believe that dialogue with you know, at the federal level but then also recognizing with the states because so much of this falls with the state jurisdiction when it comes down to you know, building resilience in the infrastructure in the limitations that we have, you know with standards.

So I think it's -- we certainly started down the right path here and continuing that with the dialogue and expanding it with the states is good.

MR. GALLOWAY: If I could add on that as well. I

think your comment earlier about kind of the water sector. I certainly agree with that and we've talked a lot about gas. Communications, I think, was alluded to earlier. A lot of the work that we've done has underscored the importance of communications in any kind of a black sky type of restoration issue.

So to the extent that the Commission can work kind of laterally with other relevant agencies that each a common definition and objectives on resiliency I think that would be very helpful.

MR. LAUBY: I'd like to add, I think that the industry is taking this focus that began with the DOE report and then of course the FERC requesting the ISO RTOs to respond with their activities and then to apply to comments has really helped to focus a lot of energy and understanding around where we stand with resilience and how it is conceptually part of the liability fabric and eco-system.

Now the question really is and we go back and focus on this kind of changing landscape of risk and now for example, we've talked a little bit about inverters and we've got a three-pronged approach there and now we're looking at the, you know, the fuel assurance.

And I think stay engaged -- we of course worked with FERC staff all the time, they come to all of our

meetings and which is extremely helpful. The industry is taking this information on and their going to be coming forward with a set of recommendations on next steps and you know, I think that what they can do -- what FERC can do is help us do that -- let us do that and bring forward to you what we think is the best way forward.

COMMISSIONER CHATTERJEE: So in that vein, and I'd like to ask this question of all of you, maybe starting with Mark to build on that. It's my final question -- just you know, and you've touched on many of these things already but just for purposes of focus and clarity.

What's the single most important thing in your view that FERC should be doing to improve resilience?

MR. LAUBY: Again, I think I just said it, just to stay focused on it. The industry is going to come forward through NERC anyway and around with assurance. We're certainly working on inverters. You have to look at what NERC does day-to-day.

I mean we have a situation awareness and EISAC continually gathering information about the performance of the system. We're looking at the historical performance and gathering data on that. We have an offense analysis program that does deep dives on certain qualified events, so we're continuing watching.

Then we also got the forward looking, you know,

what's -- what is the changing resource mix look like? How is it shaping out? Are we making sure we have our binoculars on and continuing to watch for that.

So I think, you know, NERC is really a part of the resilience eco-system as well as the reliability eco-system.

COMMISSIONER CHATTERJEE: Wes, any thoughts on it?

MR. YEOMANS: Yeah, I'll author an observation. I don't know that it's directly something FERC can just force to happen or make happen but -- and it's in our comments but I'd like to offer -- we absolutely believe there's a tremendous amount of resiliency offered by transmission interconnects with our neighbors.

So being in New York we have some strong connections with Ontario, Quebec, New England and PJM and we just see all kind of resiliency benefits with those interconnections. If Peter is having a sunny day and they're ahead of us on the solar rather than New England needing to shut generators off during the day when it's sunny, the market systems can schedule power up to New York.

If later in the day when the sun goes down, the market systems will schedule power from New York back to New England and it just works so well. And by the time you do that times four it really, really, works well for New York.

So I just can never say enough about the value of interconnections between our neighbors as they offer tremendous resiliency benefits. First the capability to buy and sell emergency power when one side is having a very disruptive event, but just day in and day out for changing conditions -- it really, really does help provide head room and flexibility.

COMMISSIONER CHATTERJEE: Peter, I again applaud you for all the work you've done on fuel security to date. Suggestions on where our focus should be?

MR. BRANDIEN: No, I think that from a -- the transmission system you know, it's pretty well-defined, the criteria contingencies that you test the system against. We know how to build a system that could withstand the environment it's in. You hear a lot from Next Era and what they've done in Florida withstanding the hurricanes with going to concrete poles and how fast the restoration was -- making those good investments.

You see a lot of work around HUD to shield the hardened substations with EMP. So there are a lot of things that we know about or that we are going in the path to be able to improve the resiliency.

As you might guess, it could be a commercial for fuel security and we don't have those same sort of criteria around how to test a system and as Wes said, every area may

be a little bit different. New England doesn't have the storage other than LNG facilities so we really need the logistics of moving the oil, moving the LNG to supplement the gas pipeline.

Other areas can meet their systems differently than New England. I really think a focus needs to be around that whole -- let me call it energy security issue because we're getting it not just from fossil fuels, but these other resources. So I think a better understanding of how to look at the system from a resiliency perspective would be helpful.

COMMISSIONER CHATTERJEE: Thank you.

MR. BRADISH: +I guess it is a few different thoughts there. One is there's already a -- in some aspects, a significant amount of resilience built into some of the reliability standards if you will.

And so the EOP standards or the FAC standards -- even in the TPL now we have you know -- the GMD standard. You even have criteria within the traditional TPL standards that require you to look at maybe tower outages. Tower outages are getting closer to this concept of the threat -- what would make a tower go out right? What's -- why would we even look at that.

So there are a significant amount of resiliency aspects associated with the current reliability criteria and

I guess Cheryl, to your point earlier -- Commissioner LaFleur, sorry -- that the -- looking for that common practice that kind of almost I guess in some ways poker, table stakes, you need to have if you want to be in this game, you want to actually operate in this world.

These are certain things that you need to be able to do, demonstrate and be capable of. Building on some of the comments made on the transmission piece -- so where we sit in our eastern footprint or in the Peak Board and three RTOs -- PJM, SPP and Enterprise, we sit on the interface in PJM with MISO.

Our facilities make up about 65% of that interface between PJM and MISO. What is happening is the RTOs are very good at tightening up in their RTOs so they're very good at tightening that up so PJM's got a very good process to tighten up their network and MISO has a very good process to tighten up their network.

The -- I guess the -- maybe what the missing piece is that focus on what interties actually bring to you. So as when we were a stand-alone utility in the olden days, our focus was on strengthening those interties with all of our neighbors -- that was a key part of our development of our transmission grid. That part is lost a little bit as the focus of the RTOs really is really on their own system primarily and the interface between the RTOs, the seams

issues tend to you know, I don't know maybe get lower priority -- don't get addressed as well and there's challenges of bringing the two together because they have maybe different philosophies, different approaches to things.

So I think as a national grid, being able to rely on those things -- the transmission system gives you reach. You can reach out to other resources. It gives you that increased diversity when you've got variable resources.

And so you want to really want to pull on that full capability of that grid while you look at the other aspects of approaching that to, so.

COMMISSIONER CHATTERJEE: Anyone else further thoughts on this?

MR. GALLOWAY: The -- I'll try to be succinct here. I encourage you to continue to promote convergence on a common and comprehensive definition of resiliency and then incent investment in improving the bulk power system in a science-based way on point with that definition.

MS. SILVERSTEIN: Two things -- one is that as you move forward articulating what the essential grid services are -- reliability services. All of those have to be defined in a technology agnostic fuel-neutral -- I probably said those in the wrong order and performance-based -- let me try it again. Technology

neutral fuel agnostic performance-based services that actually go to not an attribute but how does something actually perform relative to what you need it to do to benefit the market or the grid for reliability or resilience?

All of those have to be designed properly so that they actually get the job done that you need, and that they show up and do what you need when you need them to be done and that you pay for those services, not just say it is shocking that we are surprised that someone doesn't provide voltage support if we're not willing to pay for voltage support for instance.

Second, we need to be looking -- stop looking in the rear-view mirror and look very far forward with respect to what are the threats we face and what is the grid that we are designing for? We have been -- we have a grid that some of the pieces are 70 to 100 years old and they were built for Ozzie and Harriet weather and we are facing Mad Max in terms of the magnitude of the threats that we face from extreme weather and they're accelerating.

So it makes no sense to me that we are sticking with designs for the grid that are for really old threats when we are looking at extremes of weather, of wind of ice-loading, of extended draughts, of water, lack of water availability or extreme weather events -- extreme flooding

and precipitation that our grid was not designed to serve.

And all of the things that people are doing today if they keep building the same designs, they may not work so things like what Florida has done are probably great in terms of hardening distribution systems and transmission but they're certainly not enough and this also requires that we re-think the philosophy of what do we harden and what do we triage?

What is better to do fast replacement and assume that some stuff is going to be trashed again and again so we need the different cheaper way to serve it so we can recover fast rather than be surprised when it breaks because we thought we built it harder but it wasn't hard enough, thank you.

MS. CHINN: Just following along with that and pointing out that in the most recent state reliability report you know, the number one key finding was with regard to the improvement in the resilience of the system and after the hurricanes in Florida and seeing the difference in the restoration times, you know.

But I've got a little bit of history in the industry and actually back in '92 when Andrew went through Florida I'll just say it was, you know, the day after or whatever, I was, you know, up in a helicopter. We were doing, you know, surveys and down in Florida City and

Homestead, you know, there was nothing as far as the eye could see and the transmission system -- concrete poles snapped like toothpicks.

But within a week the transmission system was back up, ready, waiting for the distribution system, you know, waiting for it to be there so it could be energized. So the transmission system though over time has even become more robust as the distribution system has because that time in between has changed so the bar continues to get raised.

But it's great to see in the state of reliability report that the resilience has improved so much and it continues to and that's, you know, that's through investment and so forth at the states and the utilities are doing it, so.

COMMISSIONER CHATTERJEE: Thank you all.

COMMISSIONER LAFLEUR: Thank you very much. I want to ask a question that picks up I think -- at least conceptually on Alison's comment about looking ahead rather than in the rear-view mirror.

I think all of us have referred in some way already today that we're going through a big transformation -- a seismic transformation Robb said in our power system. And it's natural to always focus on the threats and challenges we face. First of all I think that's the electric industry's personality -- oh my God are the lights

on, you never look at the upside. I mean that's just the culture that at least I was raised in.

But I just want to ask since we know that changes are coming to the deployment of more distributed resources, more variable renewable resources, there's a tendency to only focus on -- oh that means "x" that we used to have there will be less of and that must mean we need more "x".

Are there resilience upsides to the way the grid is being designed in the future that we can harness, you know, through the -- I mean I know sometimes too much is made of micro-grids, but things that the new resources towards which we're trending offer that we might not have thought in terms of before so that we're so worried about what the change was before?

MS. SILVERSTEIN: Absolutely the more distributed resources that we have, particularly if we design them or fix them so that they work to help customers when the lights are out rather than having your PV not serve you because the grid is down, the more we have energy efficiency the more which is -- I know, not you all's job, but the more that we have measures like distributed generation and micro-grids and distributed storage that can help protect customers and communities, the better.

And that means that we know that the lights are going to go out again, and again and again. And however

much we do it will never be enough to protect against all threats. So it is very important that a lot of what we do protect customer's survivability and that we design it for that purpose specifically.

And one of the important things that you can do is help the -- this, the bulk power system community better work with the folks who design and build that and permit it to insure that all of these systems work compatibly and complement each other rather than working against each other.

The other part related to that is -- you know what, I just forgot the other part, you got that.

MR. GALLOWAY: I think there's a real opportunity from a planning perspective to really think about reducing the risk concentrations right? So we have to hold like two sides with 14 in identifying critical subs and hardening those. But you know, you're basically just kind of shifting to something else right?

So, you know, taking a really strategic view on you know, knocking down those risk concentrations is an important piece. The other thing I agree with Alison's prior comment, you know, we can harden and there's some no regrets issues there but there's a lot of good innovation already in the industry in terms of interchangeability of key spare parts right, so getting like modular, single-phase

transformers that you can plug and play in a lot of different applications is just a smart play.

COMMISSIONER LAFLEUR: That was actually a question I had written. I ask this every year like standardization of equipment with -- I was hoping with all the shares programs like grid alliance and Restore, are we making any progress? Is there anything we can do -- is it an IEEE thing because I mean there's so many different specks of transformers and what's there is there but we're putting in -- not just transformers, I just used that example -- putting in new things all the time, can we work toward more standardization so we can help each other more?

MR. GALLOWAY: I think it's happening right now organically and I think that's an area that --

COMMISSIONER LAFLEUR: That's the best way.

MR. GALLOWAY: Yeah, could you know, just benefit with encouragement but you know, it's happening on transformers, control houses, you know, control centers -- you name it it's happening on a number of different places where interchangeability is something that's getting kind of baked into the approach now from the standpoint that you can't protect against everything, you're going to take a hit, but how are you going to be able to come back from that in an efficient way.

COMMISSIONER LAFLEUR: All of these comments

speak to that -- customers don't recall care if the towers are up or whatever. All they care about is their heat, their cold beer, you know, their lights, their computer, their phone to recharge and so that means water and it means the distribution system not just having the transmission up and that's where sort of rethinking what resilience means in a more -- maybe collaborative way yes?

MS. SILVERSTEIN: You asked what can FERC do and one of the things that worries me the most is that we are going toward electrification. You see EPRI and DOE pushing this hard.

COMMISSIONER LAFLEUR: Um-hmm.

MR. SILVERSTEIN: And a number of utilities are also very enthusiastic about it but it's -- we're doubling down in terms of the amount of services, the amount of load, the number of customers and the things that we can do if the power is not there.

And so I think that electrification is a great idea from a climate point of view and from the utility rate-payer's point of view but I want to make sure that we don't just gratuitously electrify everything that doesn't -- can't run away fast enough without making sure that we have the ability to protect the system and to protect all of the people who are now depending even more on the effectiveness of assisted electrification.

COMMISSIONER LAFLEUR: I think about costs -- not just the transfer costs if I have this kind of water heater and now I build this one, but what's the cost to secure that in the grid.

MS. SILVERSTEIN: Yeah, so it's important for you all to make sure -- to help make sure we don't make that run to electrification too quickly and increase the risks without increasing the protection that we can provide.

COMMISSIONER LAFLEUR: I'm going to ask -- oh, yes Bob?

MR. BRADISH: To your question around, you know, technology and what's happening there. So the resiliency problem's right -- it's much more multi-faceted, it's much more nuance than the straight reliability problems.

So there's a variety of ways to tackle the resiliency. One of the biggest impacts we've had on the resiliency of our grid is actually dealing with aging infrastructure. So as we go out and deal with the stuff that's 80-90 years -- 100 years old, we're putting in facilities now that meet today's standards and today's codes. Those facilities are much more resilient than the Ozzie and Harriet stuff that apparently got put in a while ago, right?

So we just recently experienced a hurricane in Texas and it knocked out a lot of transmission lines, some

of them we had to go find. They were not anywhere near where they were built, including a 30 mile 345 KB transmission line. But the stuff that stood was the new stuff that we had just recently built. The stuff that fell was all the older stuff that has now been replaced with newer standards built to new code.

So that alone has a tremendous amount of value. You come up from a resiliency standpoint just addressing these aging infrastructure inputs.

COMMISSIONER LAFLEUR: And Puerto Rico is obviously an extreme example of rebuilding different. Bob, you had mentioned the GMD standards close to my heart, and I wanted to ask about a different kind of resilience which is, you know, the high impact low-frequency big global threats.

In 2012 when we started puttering around and making problems on geo-magnetic disturbances, I debated a lot with Mr. McClellan whether we should include the EMP and the E-1 threat in our standards directive.

And my view at that time was that at that moment that was a bridge too far because we knew more about GMD and it was closer to the kinds of things other standards did, but I didn't mean that we'd never build a bridge or figure out what was going on with the MP and I'm curious if there -- if anyone knows, if anyone could comment on the work that EPRI and the labs are doing now, how that might play into

standards or guidelines that NERC might be involved with.

And then also I know AP I believe is the leader and there are others as well in voluntary work on hardening against E-1 and I'm interested in any insights people have on that because we all heard there's things beyond standards.

MR. BRADISH: Sure, well I'd certainly like to spend a lot of time talking about ENP. Each of our states is very interested in ENP also. So from an EPRI perspective and we're very much involved in that work -- in following that work, we're funding some of that work.

You know, they looked at the E-3 already, they did a very detailed, you know, they built on the ENP Commission's work, have improved the modeling and the analysis and you know, their conclusions on the E-3 from -- the initial threat was the ENP would have a significant impact on transformation.

And transformers are long lead time items and so therefore we'd lose all of our transformers, we wouldn't be able to get power, bad things could happen. That analysis, from an E-3 standpoint said they don't see that. They don't see the threat to the transformers. That's not to mean there isn't threats from the ENP, there just wasn't that threat to the transformers all failing and us being without power for months on end.

So that was one aspect of it. The other aspect of it is they are concerned about issues with saturating transformers, creating harmonics, creating voltage collapse-type situations and so they're studying that aspect of it.

And once we get through that analysis the industry must be better informed as to what the potential threats may be from a voltage impact, you know, reactive power voltage collapse-type impact.

And so that I think, will be very informative to the industry to look at that.

COMMISSIONER LAFLEUR: And that's all E-3 stuff, that's not the communications right?

MR. BRADISH: Right, right so the other one -- the other E-1.

COMMISSIONER LAFLEUR: I'm sorry I'm such a geek.

MR. BRADISH: No --

COMMISSIONER LAFLEUR: But you can't be a geek on reliability check Conference day, what day of the year can you be a geek?

MR. BRADISH: That's right. The other one is E-1 and by the way we're not ignoring E-2, E-2 just happens to look light lightening and we've been protecting for lightening for a long time so we are not as concerned with E-2. So to the E-1 -- that's the one where all the power

electronics begin to get concerned. And so there is direct radiation from the E-1 part of the wave and there's coupling into conductor cables -- that type of stuff in that impact.

And so we actually did several years ago do testing of that aspect of it and as a result of that testing we changed our control house design to an essence, a metal box with a lot of attention paid to how you bring things into the box.

COMMISSIONER LAFLEUR: Like the Faraday Shield.

MR. BRADISH: The kind that gives you that Faraday cage effect. So that protects from the direct radiation. The other piece of that is that you get coupling from these things on the conductors, on the wires that come into the building and so you have to shield them, ground them properly and we learned from that analysis how to do that.

COMMISSIONER LAFLEUR: That's awesome for the people in Columbus, but the people -- if the bomb doesn't go there, God forbid, you know.

MR. BRADISH: So EPRI as now taken all of that right and has elevated that and is making it all that much more and making it all that much more public. The EPRI research typically is kept close to the folks who fund it -- in this case the folks that fund it said no, make this stuff public, everybody needs to know what the threat looks

like and what the possible issues are and how we might be able to deal with them.

So we're getting there. The research is ongoing they're doing some more testing of the electronics, that type of stuff. They've got some more work to do but at the end of the day I think to your point on whether or not you have a standard I think you were right on.

I don't think the science is there yet. I don't think we understood the threat well enough -- at least the impact of the threat well enough to really kind of put a standard around it. An initial standard would have been do something about transformers and that would have been the wrong way to go.

The real threat seems to be voltage collapse and so what are we going to do about that aspect of it. Now the other piece to this, and which always is challenging on any of the resiliency stuff is to really and Mr. Naumann said this earlier and I think Tom again pulled out, is the design basis threat.

The issue is from an ENP, how big is the blast? How high up is it and where is it located in the United States, because you get very different answers depending upon what you pick for those things. And so we as an industry have to protect and we need a threat -- a design-based from which to protect and so that's where the

conversation gets hung up and we get hung up on national security issues.

COMMISSIONER LAFLEUR: Well would some protection be better even if we didn't have like a direct line to whoever we think is most likely to bomb us -- should know precisely the design-based threat. Would some protection be better than none I mean to kind of come up with --

MR. BRADISH: Yeah I think that's -- I think that's fair. You can move forward there's been a lot of public information that's out there already, not all the EPRI work is public but I think it's fair to expect folks to be moving in that direction.

And again we could do this in a cost-effective way. It doesn't mean you're going to add a whole bunch of new costs to your system, you can come up with designs that are as cost-effective as what you had previously.

COMMISSIONER LAFLEUR: I mean people come and see us all the time and want us to impose the military standard and I say that's not practical, but we're working on this so I just want to be sure that we really are collectively working on it.

MR. GALLOWAY: Just to add to the same point. So I agree we would have been misdirected to kind of go after transformers in a wholesale way based on incomplete science right? So EPRI's done a lot of good work on this. The more

recent kind of chapter here dealing with the impacts on protection system is actually a much more cost-effective way to deal with that in terms of like marshalling points that kind of knock down the input to the devices that's induced on the signal lines right?

And so there is a Faraday cage approach that projects them in mass and/or marshalling point type of filtering that you can do that's much more cost-effective that we wouldn't have moved towards absent the science being done by EPRI.

So that type of work -- and we're -- it's getting implemented now, you know, in an anticipatory fashion, it makes a lot of sense.

COMMISSIONER LAFLEUR: Mark, I'll give you the last word.

MR. LAUBY: The last word, but yeah we've been monitoring all this and the good news is that the voltage collapse, you know, from E-3 is very similar to what we see with GMD and so we understand it, we know how to model it and we are watching the results from the EPRI research and at the right time engaging industry toward a guideline or standard, whatever makes sense at that time.

COMMISSIONER LAFLEUR: Thank you, I'll yield my time to someone who's never a geek, Commissioner Powelson?

COMMISSIONER POWELSON: I don't know how to take

that? Is that a compliment or is that like a little term of endearment? Well thank you all for your presentations here this morning and very, very helpful.

Alison you recently -- say within the last couple of months penned a very thoughtful editorial research paper, excuse me, on getting really focused on wires and pole solutions as we talk about reliability and resilience and our friends in Florida who really have done tremendous work with mutual assistance, grid hardening and really as I'd like to tee it up here, learning from our RTOs where I've heard it said earlier here today in the prior panel.

You know what works in California might not work in PJM or the New England or New York ISO and I think we have to be cognizant of that as words are fluttered around about national security versus what I think one of the panelists said is energy security.

And I'd like to focus on the energy security piece because in your kind of white paper that you put out there was a keen focus on look, distribution outages are the drivers. You know, in the case of the hurricane in Florida, you know, Next Era made a decision to kind of back-off the Crystal River Plant I believe just as a security measure.

But really at the end of the day it's the wires and poles, it's the distribution customer that seems to be in this conversation. I want to say not lost, but you're

editorial talked about, hey let's stay the course, you know, this is an industry that's got a trillion dollars of investment over the last -- excuse me, coming over the next decade, spent about 80 billion last year alone collectively.

But I go back to the earlier conversation about again we're looking at plant performance, capacity factors -- I don't really think, you know, that's the issue de jour. I think going to your point in your white paper the issue de jour is the distribution network and how we attack that problem and that's to the earlier point Carol of states taking a proactive role in security adequate return on equity, providing guidance with you know, grid hardening, long-term infrastructure plans so Alison I'm going to kind of -- this is a soft ball for you -- I'll admit it, but --

MS. SILVERSTEIN: And thank you, and of course you are correct as well as handsome and discerning.

COMMISSIONER POWELSON: That's worth 500 basis points.

MS. SILVERSTEIN: So yes, all of the 99.99 and change percent of the outages that customers experience happen at distribution and transmission and almost all of them are the function of weather -- bad weather, really, really bad weather, but most of them are driven by weather.

And there's a few that happen because of mis-operations or human error, this or that or the other

thing and almost none of them happen because of fuel supply or generation failure. I grant you that we are moving toward a time when the mix of -- the engineering challenge of operating a grid that is two-way distributed, a whole lot of different kinds of resources that we haven't dealt with before in mixes that we haven't dealt with before is materially changing the magnitude of the challenge and the nature of the engineering decisions and plans that have to be made.

But this industry and the people in it have shown again and again that they are able to do a Manhattan Project kind of approach to figure all this out as long as they are forward looking rather than rear-view mirror looking.

And understanding and planning forward instead of just looking at, "It's not what I'm used to and I don't want to have to deal with that." But certainly everything I have learned in years of working with people like those sitting in this room is that we are capable of doing that and I am quite confident given the amount of research that has been done by members of the industry, by the National Laboratory, by the Department of Energy and others, we can solve this set of problems too.

I will point out, however, that no matter what we do outages are going to keep happening. Whether it's caused by wildfires or floods, outages are just going to keep

happening and I think we need as an industry to pay more attention to customers survivability because your lights are going to go out and my lights are going to go out and families in our communities need to be able to survive that -- which is completely not on FERC's responsibility list but it is an opportunity for you to work with state regulators and communities and their Department of Energy and others to help communities and distribution utilities get better at taking care of customers and helping customers take care of themselves, thank you.

COMMISSIONER POWELSON: And to pick up on that, I mean I think you're seeing it with the states -- in New York, Illinois, Ohio, looking at things like Power Forward, Next Gen grid -- looking at these kind of non-wire solutions that are out there and I think it was mentioned earlier, the cost-effectiveness of that and then applying new technologies.

I was recently at a Delmarva sub-station where you have a bloom energy fuel cell there and these are again you know, and states picking up grid resiliency bank concepts to support the build-out of combined heat and power systems and next, thanks to the work of this great Commission, my self-serving shout-out here, but I think the energy storage rule-making is going to set forth another driver in this conversation and I applaud the work being

done in New York, an early adopter when valuing grid storage, so -

MS. SILVERSTEIN: And grid storage is wonderful. Distributed generation is wonderful but remember that there are a lot of people who can't afford to do grid storage.

COMMISSIONER POWELSON: Right.

MS. SILVERSTEIN: There are a lot of communities that can't -- that aren't ever going to have a micro grid or that aren't going to be able to buy a Honda generator to sit in the garage. We need -- every time you see people dying in heatwaves in low-income housing or in high-rise buildings, we need to completely re-think how we are designing buildings and how we are designing refrigerators so that people can survive and their food and their medicines can survive a three day or a one week outage without people dying.

COMMISSIONER POWELSON: I would also go a step further and I know you're a great resident of the lone-star state but that also ties into land use planning and how we design, you know, water sheds and impervious surfaces and water run-off and managing that appropriately.

I know -- if I could tell you it's not relevant to this conversation -- it is relevant to this conversation.

MS. SILVERSTEIN: It is relevant because we keep

investing federal money and so investments in areas that probably ought to be abandoned.

COMMISSIONER POWELSON: Tom, pick up on it, I agree with you this whole notion of the comprehensive definition of resiliency as I'd like to explain it to my lacrosse moms back in Pennsylvania -- resiliency is like managed care, it has 13 different definitions, it depends on who you talked to last.

But if I were to ask you if we had the -- if you were going to write the Webster's dictionary version -- you know, what would be some of the ingredients that you'd like to see in that definition and I'm going to come to our ISO RTO reps here shortly on that.

MR. GALLOWAY: So not necessarily a soft ball question. The -- I would say that you have to take a holistic approach right and we just talked about distribution right -- that's one piece of it and kind of look at the history there but look at it from the standpoint that you're -- at least in our context, you've taken -- you're taking a big hit and maybe in a way that you didn't anticipate.

So you're now having to make some decisions about bringing back the system in an incomplete way right and working through the competing priorities on how to do that -- both in terms of the criticality of the load that's being

served right?

You can argue hospitals first, military installations -- you name it. But also the interoperability issues right on the fuel supply, you need water, you need gas, you need a bunch of other things that are going to cause us to kind of look at this differently than a traditional -- like a weather related event.

And especially if you put on top of this that it could be an act of malice and it could be ongoing right? So the definition I would espouse is you know, we obviously are centered here on you know, the electric transmission system but really kind of looking at it from the standpoint that it's a -- you're going to have to come back from an atypical situation in an incomplete fashion.

And having those mutual understandings ahead of time cross sector and with the consumers right -- you're not going to get your system back in full within three days. You may be out several weeks and what does that look like in terms of the best possible footing you could put yourself on.

So I would espouse a definition that really kind of speaks to that.

COMMISSIONER POWELSON: And I would agree with that, thank you. Peter and Wes, I guess I better drop the bomb cyclone conversation into this -- both regions were

impacted rather dramatically by that weather event.

In your case, you know, we burned oil. I was reminded it was the least cost resource that met a reliability standard and in both of our -- both markets, you know we have a reliability pricing model, we're now embarking on these fuel security studies which I support within the construct of the right narrative.

But having said that you know, what is it going forward around the distinction of resiliency and reliability -- what is it that the RTOs, the independent system operators, are missing in terms of you know, a market solution or a product that is going to help alleviate some of the -- I'll call it turbulence created in policy conversation here inside the beltway?

MR. BRANDIEN: Well, we've been looking at the gas constraints in New England for a long time and we've done our fuel security study to try to frame the risk for conversation. And we've run hundreds of scenarios based on the 23 that we did plus we took in whatever stakeholders wanted us to run we ran those scenarios.

And the reality is the New England states are serious about decarbonizing the environment and we're going to continue down this path of -- we have very little coal left. We have about 23% of our installed capacity is the old fossil steam units that we really rely on. They would

like to see those units disappear.

Unfortunately those units also come with 15 to 30 days of tankage and I hear a lot of talk about duel fuel. Some of those kind -- with tiny tanks -- two to three days-worth of fuel which causes replenishment to happen a lot. Those studies showed that we're really reliant on LNG.

So I think what you're going to see is that these renewable resources are going to be replacing these old units that have the storage capability and it's going to have to be a logistics issue -- how do we insure that we come into the season with enough fuel in whatever tankages we have left -- whether it's LNG or the duel fuel and how do we replenish it fast enough?

And we heard this morning about how do you replenish generally when it's cold it's also blizzards and how do you handle all those trucking logistics, barges, trains, you know, whatever pipelines -- whatever the logistic strategy is going to be.

How does the market incent the right infrastructure and the right arrangements to be there to turn over those stored fuels which is going to be the swing fuel to make up for the renewables going up and down.

And in New England, the states have done a very good job of energy efficiency. We're studying loads out in 2025 that are lower than the load we experienced in the

winter of 2007-2008. So we're doing a good job of maintaining the load or having the load go down, but we just have to have something in the market that incents the right logistics to be there -- to be that swing field for us.

And it could be LNG contracts, it could be oil moving into the area.

COMMISSIONER POWELSON: Not to get into cases here but the fact that we're approving a 5-year early retirement of a potential unit is alarming. Couple that with the fact that you know, I may have had my cordial dissent, but you know, with fingers crossed here that Casper is going to work to create the orderly entry and exit of market -- of new market participants when you guys embark on the renewable endeavor which as I think we did recently in the PJM jump on conversation, allowing states those flexibilities to make those decisions and allowing those customers to pay for those decisions.

But you embed that with a conversation on, you know, on a fuel security study where, you know, our customers -- and by the way there are no customers here. We don't have an industrial customer, we don't have a residential customer at this conversation which I know, is probably the inappropriate forum.

But that being said, you know, someone is going to have to pay for this and you don't want to price your

market to a point where, you know, where my old economic development hat -- I'm not going to relocate to New England and by the way I'm not going to relocate to New England when you're paying some of the highest gas costs in the country.

So I'll get off that stump but it is a concern and your area of the country -- wonderful place, Commissioner LaFleur is very proud of her region -- you are rightfully so.

COMMISSIONER LAFLEUR: That is correct.

COMMISSIONER POWELSON: Five Super Bowls, but that being said, I have a concern, you know, how this all synchronizes going forward and how customers pay for all of this and what problem, you know, in your case I know the problem we're trying to solve. We're not going to get 30 inch pipe into New England in the next five years.

To your credit you're moving down in a very tactful way of putting a fuel security study in the mix. Now, you know, Wes in your area and meeting with Brad and your team, you know, New York's on a little different path. You know, you're integrating renewables, you've gone through a venture with saving some of your nuclear plants, but -- and New York to its credit has done a lot around duel fuel capabilities within existing plants.

So to the earlier point, as the Jesuits taught me, borrow, add and adapt. We've been doing it in Western

civilization since the formation of Paraglese in Athens. That's the same that holds true in this conversation with what works in California may work in a different part of the country -- may not work and I think we need to be cognizant of that at the FERC, giving you guys that flexibility so. But Wes, I'm not going to let you off the hook here. What are some of the challenges in the New York ISO as it relates to this conversation around resiliency?

MR. YEOMANS: Yes, thank you, yes, so first of all let me start with this winter. We did have a very cold consecutive 13-day cold snap at the end of December through January. To contrast that to the polar vortex of 4 or 5 years ago while we had an awful lot of cold weather over 2 months, I don't believe any stretch is more than 7 or 8 days and we've always had concern about oil replenishment for cold snaps longer than 7 to 8 days and we did experience that this past winter.

It did work -- we met reliability. We did -- we still have a lot of duel fuel capability. The dual fuel units had the ability to get oil through barges up the Hudson River and in the New York Harbor. But all of this did have Indian Point 2 and 3 online and at full load.

Now as we know over the next 3 to 4 to 5 years, 2000 megawatts of nuclear just outside of New York City is scheduled to retire and I believe that is going to happen

and some duel fuel GT's have retired.

We have the City of New York really trying to get all generators off number 6 oil on to number 4 and then eventually to number 2 which is very challenging. We have an effort where most of all of the GT's built before 1992 over the next 5 to 10 years will be gone out of New York City so we have a lot of tough challenges with look to losing some duel fuel which is kind of a cornerstone of our reliability and losing 2,000 megawatts of nuclear.

So we're going to do a resiliency study similar to what PJM and New England is doing to try to identify now where these high-impact events that will be disruptive. Commissioner LaFleur did ask earlier about some positives so I just went through some negatives that are coming, but we do have some positives coming.

We do have efforts underway for new transmission built in New York. We have the Western Public Policy has been approved. We're getting very close on the AC proceeding across central, east and CINI which are two largest binding constraints. We are integrating storage. You know the State of New York has a significant renewable plan going forward with their -- which we'll include some solar in the lower Hudson Valley.

A lot of it upstate, but some in the lower Hudson Valley which will help and certainly technology is a

favorable thing whether it's integrating distributed generation into the wholesale market -- that can only help getting storage into the market, can only help and other technologies.

Just smart metering and smart grid where you have the utilities such as National Grid and Con-Ed and others really sending signals to customers to curtail usage during tight situations. So a lot of positives -- there are some challenges ahead of us and we're going to do a resiliency-type study and apply these disruptive events and really try to take the net of the positives and the challenges in a way that what future products and market designs do we need even above and beyond what we have today and that may be additional quantities of ancillary services and maybe ramping products and it may be some other things -- so it's still yet to come.

COMMISSIONER POWELSON: I think your point is and the point that we heard earlier, provide us that flexibility because what's working in New York again, you know, may not be conducive in the PJM marketplace, so, thank you.

COMMISSIONER GLICK: Thank you, first of all I did not know that Commissioner Powelson was handsome and discerning. I should have shown him a lot more respect during his time here.

But Miss Silverstein I could start with you, you

know I really appreciated your comments -- your written comments on the risk of subsidizing inflexible, inefficient and less dependable coal plants which may well make power systems actually less reliable and resilient.

And instead you were suggesting that we should spend our resources on other solutions that provide much better benefits. I was wondering how do you -- at this Commission but also the State Commission's should think about that in terms of prioritizing those resources?

MS. SILVERSTEIN: Resources and activities that serve multiple functions deliver multiple benefits. If you only feed a generator -- subsidize a generator, all you get is generation. If you make the transmission system stronger and harder, you make it better able to resist and survive and serve through a wide variety of threats and risks.

If we invest a lot more money in interoperability and extensive sparing we will have the ability to respond more effectively to a wide variety of threats and attacks and to help a wide variety and breadth of partners across the system, not just the people who make the individual investment.

So that I think the goal is look for things that have co-benefits -- tree trimming, it's the gift that keeps on giving, every season -- spares, mutual assistance programs, emergency drills, these things it's hard to go

wrong and it's hard to spend too much money on tree trimming or spares or drills.

And so these are things that we know work. Storage will very soon be economical and in a much wider variety of applications and there are ways that has benefits for renewables integration, it has benefits for resilience, it has benefits for customer survivability.

These are things that have multiple uses and multiple benefits and therefore are likely to be significantly more cost effective than just one purpose, one shot investments.

COMMISSIONER GLICK: In your written statement you also -- kind of different subject, but you also mentioned increased harmonization and gas electric coordination and harmonization and I know the Commission has taken some steps on that but there's still a lot on the table.

I was wondering if you could just discuss what you think the Commission and the industries -- both gas and electric should be doing in terms of gas, electric coordination to improve resilience?

MS. SILVERSTEIN: Well clearly you need to be talking more. I was struck by the fact that several of you have asked the prior panel about whether we need better gas pipeline cybersecurity without actually bothering to ask any

representative of the gas industry how good their cybersecurity is, whether it needs to be improved.

And which is not to say that everybody can't do better in cyber but maybe you should ask the experts who don't happen to be in this room.

With respect to gas electric coordination I -- that is not my area of expertise and I can't give you a good answer, but do a lot of it please and do it quickly.

COMMISSIONER GLICK: On the same subject, so Mr. Brandien, you know, I know that former FERC Chairman, Joe Kelliher testified recently before the Senate Energy Committee and I thought his testimony was pretty interesting. He was talking a lot about New England, he got some questions about gas pipelines in New England and so on.

And he suggested that actually that the region doesn't need additional gas pipeline capacity that in fact we're only talking about problems that exist, you know, maybe 12-15-20 days out of the year and maybe building a new gas pipeline might not be the best decision to make.

I was wondering if you could talk a little bit about -- and I know again the ISO doesn't initially oversee the gas pipelines but what do you think can be done to make better use of the existing gas pipeline capacity in New England to make the system more resilient?

MR. BRANDIEN: New England has limited pipes

coming into the region. Really we have a small one -- about 300,000 coming from Trans-Canada through Maine, hooking up with the Maritime Northeast Pipe which you know, call it a BCF of gas but there's no supply at the end of that pipe except for LNG.

There's some off-shore facilities off of Nova Scotia, but they're scheduled to be shut down. They're just not economic to poke another hole in the ocean when they're fracking gas and bringing it in on the two pipes from the west and then another pipe that comes down through it.

So there's limited pipes. For the most part they're full and we're heading to an area where we're relying on the LNG which is to the east in counters to flow. So it's -- is there a way to get better coordination between electric generation and LDC to better -- to ensure that the electric side isn't shutting customer's down if the gas side can conserve.

So I think it's -- we have got to make sure the LNG is there and pumping in from east and flowing west to counter the constraints coming in.

And then how do we coordinate the gas in New England to make sure that you know, it's -- that we're not doing something extreme on one side if we could work with the other side for some gas conservation on those days that we've really run out of fuel to do it.

Because it's not that the electric load jumps in New England in the wintertime -- the fuel disappears, that's what I'm struggling with. The load doesn't go up, it's the fuel disappears. So how do I make sure enough of the fuel stays around that I can keep the lights on?

COMMISSIONER GLICK: I was wondering if other panelists have any suggestions on gas electric coordination?

MR. LAUBY: Thank you for the question. I think that the industry has been kind of in this game for quite some time. I think that we need to start thinking about coordinated studies, coordination between the industries to a certain extent so we can understand contingencies and impacts on the mutual systems themselves.

I think, you know, looking at how they nominate gas over the weekend for example which is you know, not the same you know, as Jim Robb was talking about, the different speeds and impacts on the system.

And maybe and of course I don't to speak out of school but when it comes to technology we have a -- and I think you'll hear about this on the next panel -- demand response for the electric industry because I know how much demand response there is for the gas industry but balancing the two so that you could actually optimize.

And we have two different models -- one group that says basically you know, you have to pay the firm to

get the pipe and when you think about it when we had firm contracts with coal we had railroads and barges that we were paying for with that firm, with that firm's contracts and vital as well on the top.

And of course nowadays, you know the pipelines are there, we're taking -- they're being taken advantage of, of course as much as possible, but somehow we need to start looking at how we might coordinate the planning and how we coordinate some of the operations.

COMMISSIONER GLICK: Does anybody else have any --

MR. YOEMANS: I guess I would agree with Peter about the pipes certainly seem to be very close to fault most of the time. And we're interested in that and we look hard at that because if we receive the generator D rate on a day where maybe a large pipe was only 80% full instead of 100% we'd scratch our heads and say it looks like something's broken here, why couldn't that generator get gas -- but that's not our observation.

Our observation is that the pipes are full just about all of the time. It seems to be a fairly elastic responsive market and I don't think we at the New York ISO have any suggestions for that.

Now I will say we're going to need to reach out for help from the gas industry as we think through and do

our resilient study because we're going to need to understand better as we pick some very tough scenarios like loss of a gas pipeline. What are those implications? It just is not obvious if you lose a section of pipe or a compressor to what degree it's a network system, to what degree they can schedule a back house service from the other end of the pipe, you know -- just what the implications are -- the worst gas contingencies -- a small amount of megawatt to a lot of megawatts so we're going to need help with that.

MR. GALLOWAY: Just one follow-on comment. I think it's commendable the work that's been done in New England kind of managing through the cold weather. We talked earlier about kind of design basis threat right -- so obviously the continued shift in reliance on gas in the Northeast represents a significant change.

If the overlay and uncertainty about how robust their cybersecurity is -- you know, we now introduce into a common mode issue right, that we hadn't seen before so that would be something that would be on my radar.

COMMISSIONER GLICK: You mentioned something earlier I thought was interesting. You were talking about obviously the need to incent investments in the bulk power system and obviously some of that is transmission.

I was curious if you think that the Commission's current policies or current approach to incenting

transmission investments with transmission you know, adders and so on are the right approach and we need to take a second look at that.

MR. GALLOWAY: I would say that kind of in a context of everything we're talking about today we just -- we want to scrutinize it to make sure that you're getting the investments in the areas that you would anticipate on point with the definition of resiliency right?

And it's not -- it is to me it's related to reliability but it's not a complete overlap so you have to really kind of look at it from a different standpoint. I think investment in things like interchangeable spare parts, you know, things like that to make that really kind of a no-brainer type of thing across the board would make sense.

COMMISSONER GLICK: Finally I wanted to touch on a point. Mr. Yeomans brought up the point the benefits of being interconnected with other regions and so on and how that improves resilience and that seems to make a lot of sense. And I don't want to get into the big -- I know there's all sorts of jurisdiction arguments with regard to ERCOT and so on and I really don't want to go there too much.

But it's always struck me that you know that Texas would be much better off if it wouldn't be so concerned about whether FERC is jurisdictional or if it's

the ERCOT portion of Texas. And I was curious I don't know Mr. Lauby if you have any comments about do you think it would benefit putting aside -- not just that we should subject Texas to FERC jurisdiction, but just create an interconnection between Texas and neighboring regions and so on -- do you think that would improve the resilience of the Texas grid or ERCOT grid?

MR. LAUBY: That's an interesting question. All my exes are in Texas, that's why. No, I think the -- if you look at for example some of the challenges their having this summer. If, obviously more transmission -- even if it's DC, back to back more availability of megawatts to bring it in could have been helpful.

But they you know, they manage their system carefully and I think even with the hot summer they've been able to get through it.

MS. SILVERSTEIN: I think my old boss Pat Wood sends his regard, would suggest that when you all figure out your problems we'll be happy to join you but we'll do so by DC rather than AC, thank you.

COMMISSIONER GLICK: Touche.

COMMISSIONER CHATTERJEE: With that thank you all for another great panel discussion. We're going to break for an hour for lunch and then reconvene at 1:30.

(Lunch 12:30 - 1:29).

PANEL III: Managing the New Grid

COMMISSIONER CHATTERJEE: If everybody would just go ahead and grab their seats, thank you. Thank you all. I'll let everybody get situated and settled after lunch. I hope everyone got lunch.

I want to welcome our next panel and again thank you all for your participation and your submitted testimony and looking forward to another engaging discussion. It's been a great start to the day so far. We're going to do things in reverse order for this panel, so my colleague Commissioner Glick is going to lead us of and then Powelson, LaFleur and I will close it, thank you.

COMMISSIONER GLICK: Well thank you very much Commissioner Chatterjee. Thank you all for being here and I appreciate the discussion we had this morning -- that was very interesting. I just have a few questions and maybe I'll go down the list here. First of all Mr. Moura in your written statement you mentioned that essential reliability services are evolving and obviously the grid is changing and everything.

I was wondering and I noticed we had a discussion on the previous panel about this but do you think we should be thinking about essential reliability services differently than we are today?

MR. MOURA: Alright great, well thank you for

having me first of all Commissioners and it's wonderful to have this opportunity to speak on this panel. For those of you who don't know what I do on a kind of day-to-day basis, I do long-term reliability assessments and seasonal reliability assessments and essentially run NERC's reliability assessment program.

And part of that evaluation has been more recently looking at those essential liability services. I think one mistake we can make very quickly is that ERS or the Essential Reliability Services is something new. It's really something that the grid has always had and always provided.

In fact we've built and planned and operate the system around what we call a suite of essential reliability services. But to really think about actions in terms of you know, how we're going to -- what are solutions? What are assessment obligations and maybe how markets react to you know, bringing on and maintaining essential reliability services.

You really need to kind of dive down a little bit than the broader concept of ERS and really think about frequency response, inertia, voltage support, ramping capability, ride through -- all of these potentially have different paths around solution sets.

For example, voltage control is something that is

very inherent within spinning electricity, spinning generators, it creates voltage. It's kind of one of the by-products you get out of spinning copper around iron when you produce electricity. And maybe not as marketable as something that's more broad like inertia or frequency response.

And so the solution sets to assuring you have enough voltage support might be different than what I would do to insure I have enough frequency response. And so I think the way we've been thinking about -- to answer your question more directly, the way we've been thinking about essential reliability services is right on point in fact.

We've been working with the Commission and I think there's a bravo to the Commission on recent orders requiring the capability of frequency response. I think that goes a long way. One of the issues we had struggled and were concerned with probably about 5 or 10 years ago was lack of frequency response of capable generation.

But we know that the capability is going to be maintained and that's a really important aspect. What we do later in operations around incenting performance or providing rules for performance -- that can all be accomplished now that you've got the capability so I think that's really important.

Another area as we've seen more definition of

frequency response and we've been able to look across an interconnection and say, "This balancing authority is going to provide this amount of frequency response and this balancing. It's going to provide this amount of frequency response. We've been able to measure it and allocate responsibility across an interconnection.

And finally, for you know, something like ramping we've seen market products form -- again out of the results of measuring what's needed. And so California ISO has ramping products and you know they look beyond just the spinning reserve products and cover long period -- longer period of time.

That evolved in California because of the need in California. And I'm certain that those needs will evolve in other areas as the risk and the issues evolve in those areas.

COMMISSIONER GLICK: I was wondering if you or maybe anyone else on the panel thinks that there's things that the Commission should be doing that it hasn't done yet to promote -- to provide the incentives to provide these essential liability services as the grid starts -- we're in the midst of a change.

MR. MOURA: Yeah, well I could go ahead and start and just say that I think the Commission again has done a lot and NERC, from -- in its role in pointing out where the

issue is has also done enough with it being kind of state of reliability report which is kind of backward looking.

How is the performance -- but also what are the future risks and so that's been successful and we've actually seen certain products within the markets evolve and try to offer those products, others?

MR. NOVOSEL: I can actually comment and again thanks for being able to participate in this panel actually. I would call it a geek panel for the reason because if you talk about reactive power and frequency response, have you ever tried to explain this to people who are not engineers -- I think that's very difficult so.

So actually that's one of the elements of how we communicate essential reliability services and how connect reliability standards in markets and I'll come back to this but I want to address first the issue.

If it is investor-based generation there is somethings a lack of understanding how -- because there's always an issue that we have more inverted regeneration, we have no lack of inertia, it makes it more difficult and that's correct.

At the same time inverter based generation actually has more flexibility and could be actually faster than conventional generation in responding to the changes in the system -- so it's actually good and bad because again

flexibility and speed gives you either some advantage.

But at the same time you know, conventional generation has this inertia that automatically in a way in time reacts to changes in the system. So now in inverter based generation you have to really coordinate, you need to know what's happening, you have to have visibility. You have to have models so it makes it much more difficult to actually operate even if you have some of those capabilities available.

And then when you talk about ramping -- this whole issue with can you ramp up inverter-based generation? Yes you can but it has to be built with the situation that you have. So will solar panels actually say okay, let's reserve certain head room so if we see changes in load we'll react.

Not we want to sell power -- no. And again the ties to this reliability standard should actually be the ones that will affect how the market is being developed so it is not market versus reliability standards, it is a combination of knowing what you want to accomplish through the standards and then have the market that will value what they tried to accomplish.

COMMISSIONER GLICK: Anybody else?

MR. BARTLETT: I'll pile on a little bit. One of the things I think is very important -- I think the points

that have been made so far are right on target. You know the inverter-based resources are absolutely where our company is adding resources and our customers are adding distributed resources.

One of the issues that I think we need to focus on going forward is how do we characterize the components that are being added to the system? When we add a rotating piece of equipment we know what constants asked for, we have models that are tried and proven. IEE, 17-41 I think has gone a long way toward helping us define on the generation side what we need to model for going forward.

I think it's very, very important that we encourage manufacturers and especially even smaller distributed-based inverters to ensure that we understand what's going on in the system that we can effectively model it and insure that we don't spend good money after bad trying to cover parameters that we can't model with reserves -- that's not an efficient use of our money.

We think there's a great future here. I totally agree with the idea that the speed with which power electronics can react is a real advantage to our grid, but we just need to have a common language to deal with all of it.

MR. MILLER: Thanks, so I spent the last 58 or so years working on the controls for grid, for inverter-based

generation and most of these points are spot on. There's a couple of additional ones that I'm not sure I have an answer for you as to what you should do, but certainly a cautionary note and that's:

One is inverter-based -- there's a lot of flexibility and we don't know all the answers to what is the most desirable behavior. There's a lot more knobs that can be tuned with inverter-based resources than you have with synchronous machines, that is good news and bad news right -- the potential to do systemic harm is there.

So we want standards that I think, and market signals that are outcome based not enabling based -- it gives the manufactures the flexibility and the system designers the flexibility to use the capability of the different resources situationally as well as they can. That adds complexity to the planning problem and other things which we'll need to deal with.

Another complexity that I see that maybe is a role for FERC is that there are some of these resources that now are neither fish nor fowl. There are times when they are generating resources and there are times when they are network resources.

And it seems like that really causes some significant paralysis and I'll give a couple examples might be -- we have a big solar developer in the room here that I

know right? Their plants are perfectly capable of providing closed voltage regulation at night when there's no sun.

But that's quite a difficult market problem because the bars don't travel and we keep -- at NERC and others that kind of wrestle with that so you need a bar market but the bar market is not -- doesn't travel like frequency and so there are other parts of the time when that plant is going to be, you know, a generating assets and it's pretty well covered.

So we need to have some new kind of recognition of that kind of variation. Another one that I see that I've worked on is for example, when we're talking about some of these big fossil synchronous machines -- both fossil -- whatever being retired -- the grid grew around and sort of hub and spoke fashion -- that's very true in the west with these assets that are at the right spot in the grid not by accident but by practice, and yet there really isn't a terribly good mechanism for those retiring units to turn into for condensers because their network assets and they really won't pay the rent but it's location, you can't do a clearing so that's the challenge.

I don't have an answer for you as to how you solve that but it's an important one I think.

MR. GREGG: Hi there, I'm going to provide a bit of an Ontario perspective to this as well. And I'll first

start by saying I agree essentially with everything that my panel mates have said, particularly what Damir said. I think it's not standards or market mechanisms -- it's both, but that's certainly been our experience as well.

And so when you look at Ontario context -- we're second only to California in North America standing in terms of the amount of distributed energy resources we have on our grids.

We've got 3300 megawatts connected to the distribution grid in Ontario and one of the things we've learned is that grid has evolved is that a critical step is to make sure we do regular, periodic forward-looking operability assessments to ensure that we understand what the challenges of the new resource mix are and identify any reliability needs that are coming as a result in a timely manner so we can have sufficient time to acquire the resources we need.

And we've seen some really interesting areas of innovation in this sector, particularly in the area of frequency regulation so we did an auction last year so competitive procurement where we saw storage actually competing in the market and ended up awarding on a best-cost basis, two large batteries and providing just over 50 megawatts of regulation services in Ontario.

And so the point there is that I think innovation

is happening for those technologies are competitive and we saw that procure at a price that was 40% of the original traditional price for regulation services.

MR. JONES: If I could -- I want to just add a few comments here because I think that we're all kind of hitting, you know, on the key attributes as we talk about essential reliability services and you know, as we think about the portfolio of generation that was built in the '70's, '80's, those services were just kind of givens and we really didn't think about them, and I think now as we see that the portfolio is changing we are starting to recognize the value of some of those services.

You know I think the recent action taken with the small and large generator interconnections is taking care of the frequency side of it -- we've got to keep our eye on it but I think we've got that box checked.

The one I think we really have to pay close attention to here though is ramping. You know, we've heard about a lot of renewables in California, CALISO -- they've talked about the duck curve and we've seen the graphs. Well I'm going to tell you the duck has flown across the country, now it's in North Carolina. So, you know, we're not in a market but we're dealing with it and so it's finding those solutions that work best to provide those ramping capabilities.

And I think, you know, from a public power perspective I think we come at it from the, you know, let's not pick winners and losers -- list aside what those attributes need to be, you know, that provide ramping capability and then let's let -- as the technologies evolve, those technologies can provide those services, you know, let them participate and offer those into the market.

So I think that's key here as we continue to move forward is, you know, let's make sure that we recognize first off --

A -- we do have a ramping problem and then B -- let's make sure that we're looking at it holistically in making sure that we're not picking winners and losers here.

Let's set up a market design market that allows anyone that can offer those services to offer them. I'm going to go back to my MISO days and give you an example here. When we designed the energy and ancillary services market at the Midwest ISO, there was an 80 megawatt aluminum smelter down in southern Indiana, and they came in and changed out their control systems -- an entire change-out of the control systems so they could offer in regulation in 10-minutes spinning reserves into the energy and ancillary service market.

So it's that kind of creative thinking. It's not just the old conventional generation. It's not the new, you

know, renewables, but it's looking at it holistically. Let's identify what those attributes are and then if the load can provide it, let them provide it.

COMMISSIONER GLICK: I appreciate that, it's very helpful. Mr. Miller I do want to -- you mentioned, I think you were talking about some of this on the break before this panel but yeah, in reviewing your written statement you were highlighting the need to change our thinking about issues such as synchronous inertia and black start and under frequency load shedding.

And as, you know, the continued evaluator thinking in standards associated with the grid, I agree it's important to think forward and not maintain -- not attempt to maintain some resemblance of how things used to work.

But what do you think FERC should be doing, if anything, to you know, to help move these technologies along -- these services along?

MR. MILLER: Well I think that certainly you're already doing some of the right things in that we're avoiding -- I mean part of the answer is avoiding unduly prescriptive answers to these reliability questions so I think Roy said it very well -- set the stage so that things can move along.

We are today we are definitely today still with the situation where there is a requirement for synchronous

inertia and in my testimony I acknowledged that but I'm also poking a stick at the notion that that shall be forever and it need not be -- we know how to make systems without synchronous inertia. So we don't want to codify that and I think that's another cautionary note.

Consequently you want I think to make you know, market structures and rules that are outcome based -- reliability outcome based that don't necessarily say well -- for example market firm synchronous inertia I think would tend to codify that and I think that's probably a mistake.

I think some people would disagree with that but the notion that as Roy said we structure rules and markets to make the absolute widest possibility of participation is essential.

And you know, it's been -- I think all the panelists today have acknowledged in one fashion or another == the notion that the loads are a key part. I want to emphasize that and Alison made a point about electrification right?

That's -- the writing is on the wall and I think FERC -- it's important to recognize that electrification is happening and that it probably can't happen on the same terms as we've historically have of, you know, consumer is a consumer, consumer is uncontrollable, kind of unknowable and the electric supply shall do everything.

We just -- we can't at a societal level afford that. So as you make rules it wants to be such that the loads can be much more active participants and he gave a good example of that but that needs to be built into the fabric of our thinking going forward, not the occasional aluminum smelter which is a great example.

COMMISSIONER GLICK: Turning to Dr. Novosel for a second. In your written comments you describe some of the foreign policies that are way out as markets outside of the U.S. in which they've worked on accommodating changes to the electric system, you know, from the centralized one-way grid to one where DER is rapidly being adopted.

I'm just wondering if you can identify some of those policies you think might be adoptable or something that we should approach -- that we should look at here in the United States.

MR. NOVOSEL: I think it's always good to learn and apply best practices, you know, across the globe. And you've seen that in Europe there was a big push for wind for renewable generation in Germany and solar as well.

So at the same time we've seen they've actually created some price increases so if you compare the prices in Europe and you compares the price for electricity in the United States, they're double.

So I think lesson's learned that we actually --

that lots of good policies, lots of good things have been done but I think one lesson learned is that the test to that in a structured approach and addressing the consequences that some of these initiatives have for the ratepayer -- that would be one example.

And at the same time you're seeing that Europeans have these very aggressive targets but there is still lack of coordination among the nations. So they're trying to put now the process to have some of this more inter-country transfers and markets because -- again I'm not an expert, it's just I looked actually at the document at FERO, it's not my document -- it's a document that was created by Triple E members.

Because -- and I do want to emphasize this -- our approach is that we provide unbiased, industry perspective because we have academics, spenders, utilities on our team. So one of the members who actually incidentally is sitting here in the room, Veronica Rable, was the one that threw that piece and I'm just presenting this.

But based on our discussion it's very clear now that there's still lots of work to do because 12% of the market is actually going through the interconnections in Europe, so it's still very nationalistically focused. I think that's one of the lessons learned, thanks.

MR. MOURA: Sure, I have some experience in

working very closely with our European counterparts. We both, for example, the SOE organization is somewhat similar to NERC's role in doing wide-area interconnection analysis and assessments.

And so in working with the Europeans, some of the things we've learned is they are going toward -- they do have energy policies around where they want to see their resource mix in the future.

And one of the challenges they've had is that they have so much curtailment of variable resources right now and in talking with the Germans specifically, you know, one of the things that you know, stress, you know very often and it is really from every sector I talked to -- whether it be renewable developers or transmission operators.

They said building your transmission early because if you don't it's going to be -- you know, once you start getting curtailments then it's another 10 years or so to get that transmission system that you really need.

The one other piece of advice that I think is worthy in the conversation is you know, they did go to an -- Germany did go to an energy-only market and because of that construct they were worried about loss of synchronism because their primary new resources were going to be renewables.

They don't have the luxury of significant amounts

of natural gas to provide that and so because of the risk of loss of synchronism they did put together kind of a fuel security capacity secure-type market so that they would have this kind of insurance policy built in for coal and nuclear units that will hang on during this transition of going to more renewables.

And so it's something that is a short-lived program. I think it only goes to 2024 or 2022-2024 but does provide them some inertia security going through the transition.

COMMISSIONER GLICK: Thanks, I just have one last question, it's for everybody and it's kind of a broad question but you know we've touched on energy storage here a little bit today -- but we haven't really talked a lot about it I think, and you know, that's another question recently that Commissioner Powelson had referenced earlier to facilitate participation of storage in wholesale markets, but I think it's a good step forward and we've obviously had Technical Conferences here on this subject and put them to the issues should other others be looking at storage as well.

But I was just wondering if you all could talk about some of the reliability benefits associated with storage, especially now -- it's getting more economical and where you see storage in the future playing a role -- how

you see it playing a role in a more resilient reliable grid -- do you want to go down the table?

MR. MOURA: I'll just start really quick. You know, I'm very similar to Commissioner LaFleur in that I'm trained to look at all the problems and you know, all the benefits don't come immediately up -- but you know, they eventually get there.

But I think primarily is you know, the whole concept of balancing. I mean the simultaneously balanced supply and demand is a fundamental construct and a constraint in our operations. It's something that we optimize and we try to work very hard to do day in and day out.

And with more storage you get some more flexibility with that whole challenge. The other concept that Damir related to was, you know, the battery connected to inverter can really do some amazingly fast things and so I'll just leave it at that because I know others will have some input.

MR. NOVOSEL: I think that you mentioned already having storage play on the wholesale market is a big thing because at the end of the day storage in U.S. have class and if you treat it as a commercial asset and class fuel you'll never really utilize the benefit of storage to the full extent.

So it can be load, it can be a generator, it can be a transmission asset, but applications like N minus 1 congestion -- very good application for storage. And even with the present cost of storage there are now, use cases that show that storage is actually cost effective in that case.

Again, it's not the solution for everything -- let's make it very clear but it has already now cross benefits analysis. But I think what is really important now on the regulatory side -- beyond this, you know, using it for spec'd applications is to understand that it really needs to be done in a structured and consistent way.

Let's say if you're going to have two gigawatts of storage in your state, let's put two gigawatts of storage and let's see how it goes. Let's have a plan -- a roadmap, a process -- the tools. I think that there is lots of discussion on both sides of the aisle I would say, whatever you call it. Some people say storage is the solution for everything, some people would say storage is expensive it doesn't work. And both of these comments are not correct, actually with solar the truth is somewhere in the middle.

So if you do a proper cost benefit analysis you have the procedures and tools to identify what the right size of storage, what's the regulation of storage, what's the right location of storage -- then you will find that

actually there are some good business cases. But if you don't do that it becomes an asset that is not serving really the purpose. I mean it's good for the rate recovery and all but it's not really something that brings you the value that it should.

I think I would really encourage to do this type of roadmap, planning and you will see -- I actually had a discussion with Gordon Rodriguez just a couple of days ago, CFO ISO New England and he was telling me about 1800 megawatts of offshore wind.

So now how can this 1800 megawatts of offshore wind, how can they affect the grid and of course this whole issue that we heard today with discussion on natural gas dependencies and all and how it can tie together.

And storage can fit this really nicely. Storage can be a solution to address this off-shore wind interconnection and all.

So, but again this is something that has to be planned in detail.

COMMISSIONER GLICK: Mr. Jones?

MR. JONES: I just want to add, you know, as we think about, you know, storage, there's probably multiple applications for it and once again I'll kind of go back to the markets, you know, in making sure that as we look at it from a market's perspective that you can optimize it within

your market solution whether you use it for peak shaving, use it for ramping, use it for frequency and I'll tell you there's even a resiliency component to it.

In North Carolina in the Outer Banks in Ocracoke, we've got solar panels out there that are owned by the co-op and they've got battery storage out there and that was all put in place, it's almost the micro-grid concept that you were talking about earlier Commissioner.

And so they've recognized the issues out there is we have hurricanes come through North Carolina -- especially the outer banks. You lose electricity for long, extended periods of time. So there is a place for storage and I think it's, you now, there's a resilience component to it, there's a markets component, there's -- you know, a ramping, you know, essential reliability services.

So once again there is a role for batteries in our grid.

MR. MILLER: Can I -- just real quick. This conversation extends beyond batteries too, maybe just because it's most recently in my mind but pump storage -- alright, so it's a real big scale and Commissioner LaFleur's old turf.

You know I was talking to the manager of operation's planning and they love their pump storage right, you know. "If I could marry a power plant, I would marry."

But that -- and it's got the resilience term and all these other things, but it's not clear to me that the market structures and you know, I don't think anybody would build another bump surge in New England yet despite everything we've heard today.

So it's -- I think the comment that different market, a different -- has got to be real and somehow or other you know, this broader cost benefit than our current thinking I think needs to be brought in against my other role of don't be overly prescriptive right?

So yeah, the big -- and just one last nickel on that. The pump storage -- I've been looking at projects in California with variable speeds so these are inverter-based devices. So you've got epically big generating and load resources that have the same sort of you know, Ferrari-like performance for grid stuff that the synchronous machines lack -- so there's another term around these tests.

MR. JONES: I know we don't have an ISO person on the panel but I do know that NYISO clearly has a lot of pump storage as well and what they're beginning to do is, you know, they've got white papers out there because they're starting to recognize the value of pump storage just beyond peak shaving in the energy market. So you know, they are starting to recognize those other attributes of pump storage and the flexibility in value that it does bring so we're

starting to see some movement in New York with their new market designs around ramping.

MR. MILLER: We are not a research organization. You know we're there to serve retail and wholesale customers but if we had a research around batteries is where it's at. We see an extraordinary amount of potential with batteries and it seems like the more we study what we think the future is going to look like, the more applications we find for batteries so probably piling on a little bit so let's don't be too prescriptive with how we use them but I think we need to be very careful to encourage experimentation and really look at the various value streams that a battery can bring to them.

Because I don't know that at face value you see the entire economic picture of adding batteries, especially in a power system where we're adding a lot of inverters which are working close to full capacity being able to add some fault current, being able to react very, very quickly is an extraordinary attribute so I think we have to do everything that we can to encourage some free thinking and see how we can extract all the value possible from battery storage.

MR. NOVOSEL: May I just make one more comment on this. I just want to emphasize when we talk about and I can't agree more with Jay and Roy about market and benefits

and all.

If you have a storage that is 20 years now where the performance 20 years from now will be the same, what are you really doing? You are paying premium that is about two, two and a half times what you will be paying for regular storage.

Now if you know the technology will be changing, maybe flow batteries will be the technology of the future. So now if you do a cross benefit analysis and you are using, you know, projected costs with say with flow batteries, you're getting completely different case than you are doing in 20 years of battery, with exactly the same performance 20 years from now.

I just want to emphasize how important it is and we do this cross benefit analysis, we do it the right way. The other aspect is let's say the PJM who was paying a lot for frequency regulation use and storage. And again, we just have to be careful like we are careful with PV's and all.

Lots of you know, vendors, actually put storage on the system but then too much storage in the system for frequency regulations but again, if you don't go back now to the stacked applications, you're not really utilizing the markets in the right place, that's to your point.

And the last point is with FERC and ISO's I think

like competitive transmission I think it's moving to the direction of non-wired solutions. I think it's a really good approach. Let's look into some of the other possibilities and encourage some of this deployment, thank you.

COMMISSIONER: GLICK: Mr. Gregg, did you have?

MR. GREGG: I'm not sure I've got anything additional to add that my colleagues haven't already spoken about, thank you.

COMMISSIONER GLICK: Thank you very much.

COMMISSIONER CHATTERJEE: Commissioner?

COMMISSIONER LAFLEUR: No thank you very much Mr. Miller, at the Reaman Orchard we used to call Bear Swamp the jewel in our crown and the Yankee atomic, the first generation nuclear plant that was built with pair with is long gone because it was one of the very first ones built but the jewel is still there but know I know it can be a Ferrari and a potential marriage partners, so it's even better.

I want to pick up on Commissioner Glick's question on storage and talk a little bit about distributed energy storage because we've been focused on that quite a bit over the last couple of years here but more from the market perspective -- how do you pay it, how do you make sure you don't pay it twice, how do you reconcile the

wholesale and retail?

And I'm interested from a reliability perspective what the tools are that we might need to put in place to make sure that it helps rather than hurts reliability as it comes and effects the stability of the whole grid. And I guess I'll start with Dr. Novosel who noted that it is a significant opportunity to invest in modernizing the grid to keep up with the DERs, could you expand a little bit and then I'll take comments from others?

MR. NOVOSEL: So there is an interesting situation now when we look into the system that with all the, you know, PVs being installed, that is the host and capacity calculation and you know, you feel it just looking in to addressing the capacity on the grid and all.

At the same time in parallel there are these initiatives on the ER evaluation. You know, how to value the field of energy resources on the system including storage and how you can actually now let's say -- not invest in some of the -- do some capacity deferrals and do some other applications on the distribution side.

To me the most interesting thing that for one level you're saying you will need to invest in the grid to be able to accommodate storage and the ER. On the other time you are using the ER and storage actually held the grid.

So again the whole point is they are addressing the holistic --

COMMISSIONER LAFLEUR: Yeah.

MR. NOVOSEL: Perspective and understanding what they need to do with grid organization. I want to emphasize this again it's not always sometimes communication where you'll hear the Wall Street Journal or whoever -- some people writing articles and there is always this -- the grid, what will be the grid in the future. You know, it will be all distributed so there is no need for transmission okay.

But the other side there is this whole idea that, you know, if you like RIMs, you like transmission. And I think the industry if they're proactive, we know where industry is heading. You don't have to have a crystal ball to know where we are going to be. It's going to be a hybrid grid -- that you will have more distributed energy but at the same time you will have still robust, it has to be robust in the grid.

If you're talking about markets and distribution, you also need to have a robust in the grid monitoring tools to your point, we need to have the tools. We need to have this ability. We talked about behind the meter storage. How do we know what's behind the meter? I think Jay emphasize this.

Unless you have that visibility you cannot really properly run markets and it comes back to your question of markets and distribution. Again, for markets and distribution -- how long it took us to get markets and transmission guides -- 10-15 years to make it happen.

And trust me distribution is much more complex than distribution. So now, maybe you're looking -- you're touching on markets and distribution the precursor. To have that is to invest in tools, in visibility, investing with an organization to be able actually to utilize those resource -- those distributive energy resources in the right way.

COMMISSIONER LAFLEUR: So is it adding more like digitization and communications on top of the grid? In other words do we see it all like we used to have the old-fashion scavus or you'd see the transformer roper or the breaker open and close but this is many steps beyond that?

MR. NOVASEL: I think we are still far away to have what we need to have and I'm sure that the panelists will actually probably know more than I know on some of these concrete issues that we have.

But we are lucky in this sphere and all and in transmission it's pretty clear what to have, what to do, what to monitor. In distribution there are lots of gas, I mean that is known, groups -- you know, energy resource management system, ADM advanced systems and all.

But it's still -- the tools are not there. The monitoring is not there. There is lots of things to be done to get there so I hope I'm answering your --

COMMISSIONER LAFLEUR: Doctor, I complete agree with you. I think it's a false debate that's set up of whether we're going to be more localized or we're going to be more regionalized because I mean I think we're going to be both and I'm pretty confident there'll be a grid as long as I'm around, but that's just kind of a thing to structure debates around. Does anyone else on the --

MR. GREGG: Perhaps just to pick up on that a bit. One of the things we've learned in Ontario is the need for collaboration across the sector as we've seen the proliferation of DERs in Ontario. And just we've struck interoperability committees -- for we deal with the local distribution companies to try to get a sense of visibility to the resources that exist in their system.

But we've got about 67 distribution companies that we're having to interface with -- all have varying degrees of sophistication in how they actually manage their systems. So some are very passive in the way they management the distribution system. Some are starting to invest in more modern distribution operation systems.

But one of the things we've found is that having that forum for dialogue around what we think the industry

needs to look like -- is it going to be more regional, is it going to be micro-grids, is it going to be the traditional grid -- that's really important and invite as many people as you can to the table to share their views. Collaboration is really key.

COMMISSIONER LAFLEUR: Mr. Bartlett?

MR. BARTLETT: Yeah, thank you Commission. For us we've been making substantial investments in telecommunications. You know we believe, no pun intended that the future's very bright with the modern grid but it certainly depends on our ability to apply computational power to the problems that are out there. That's what's different along with the inverters that are out there now.

I am very certain we can make this work and we can do so economically but we need to make sure we have robust telecommunications systems. Where we're concentrating right now is marrying the system operations from the transmission perspective with our 23 distribution providers -- getting very close there will give us another degree of control which gives us more flexibility.

The next step however, is we need to get to the distributed generation at customers and homes and that's the part right now that remains fuzzy to us but we think that's going to be as important as water, sewer and everything else to make a very clean economical future in electricity.

COMMISSIONER LAFLEUR: So you're doing things in the distribution system on your side of the meter and then that customer side of the meter is the next --

MR. BARTLETT: Right, we're working on communication so we're really blending and enhancing to a great degree our visibility, setting at the transmission level provider into the distribution systems so that we can -- it's on pricing also, so that we can have very immediate control.

One of the things that we also feel very strongly about with a great bang for our buck two ways here is on the resiliency piece of this. These new generating technologies are different when it comes to re-energizing after a problem. So it is not going to be as easy as it once was at some point, it's slamming the breakers closed.

And we're just closing our eyes while we go through the end rush current. It just won't work so we're going to -- we anticipate having much more complex schemes that are going to require much more I guess, coordination to bring systems back on. We think they'll be able to do things so much more automated fashion which all returns great things for customers but it's more complicated and it all requires robust telecommunications.

COMMISSIONER LAFLEUR: Thank you, Mr. Jones, did you want to?

MR. JONES: No, I was going to kind talk about our members in the electric distribution system as well. You know, and I can't really add anything to Jay. I just want to, you know, as we've talked about you know, smart grid and deployment of two-way communications, there's a critical key element there.

That layer -- if you will, at the end use customer level, we've got a lot of traction that we've already made over the years. I will tell you probably a year ago I was convinced that the way to the customer was through the meter and it's not -- it's through the cloud.

I mean so many devices are connected via Wi-Fi now. And all of these devices talking to each other, you know, I'll pick on North Carolina again but we've got a significant demand side management program at the eastern part of the state on a monthly basis.

We're curtailing anywhere you know, to shape peaks between 350 and 400 megawatts and we're changing out all of that technology and we're putting in the two-way, you know, smart meters. We're talking directly to the thermostats, the resistive heat strips, the hot water tanks.

And so once again it's managing that layer of information and data and bringing it up to the distribution level and having that level of visibility and then bringing

it up to the transmission level so it all gets connected and you have visibility all the way through what's going on in the system.

Now, with that having been said, clearly we've got to make sure that as we do this we're thinking about it from a cost benefit perspective as well right, because I know that one of the earlier panels was talking about, you know, end use consumers and issues they were dealing with and I think we all recognize the need to keep, you know, that consumer in mind that is struggling at times, because they're all -- we've got folks in North Carolina that are struggling and so we just have to be mindful of policies, procedures and positions and things that we do that we take and the impact it has at the end of the day on folks paying their bills.

COMMISSIONER LAFLEUR: It seems like as you get into electrification that all becomes even more important as people have more things that they're -- they've come a long way from the radio frequency signals to the set chop on the water heaters.

I wanted to turn to standards for a minute. I apologize that I was a couple minutes late coming back to this session if this was already asked, but there seemed to be different testimony, different opinions in the testimony about whether we should have a standard for inverters as

California ISO suggested or whether IEEE 15-47 would take care of it without a standard and I'm interested in starting with Mr. Moura and your thoughts on that and I guess I'll leave it there.

MR. MOURA: Okay great, and so I think you're right. I think that there are multiple and different views on the path forward and I think that that's good and actually what we want right?

And so I think a lot of this is being thought out right now and the basic part of the debate is you know, a fundamental part of what NERC does is fuel neutral, fuel agnostic, technology agnostic and therefore you know, our standards are written in such a manner.

Typically, a lot of these challenges we're seeing happen on the grid whether it be the blue cut fire related inverter response. There are other existing requirements and standards already that require certain performance and coordination.

COMMISSIONER LAFLEUR: Most of the PRC right?

MR. MAURA: Whether it be PRC but there are others. There are fact standards that require coordination of facility ratings and coordination of generation capabilities. And so we really try to think about the standards as a whole family -- they actually all work together and so you know, is an inverter standard something

that we want as an industry?

COMMISSIONER LAFLEUR: Or is it a change to some other standard --

MR. MAURA: Is it something that the transmission --

COMMISSIONER LAFLEUR: Yeah.

MR. MAURA: Operator owner is responsible for right -- insuring that devices and technology interconnected to their systems have a you know, a known operating state, have known behaviors and can be predicted. And I think that's really ultimately what's important.

I think if a certain piece of technology is unable to do something, that's okay as long as it's known and planned for and operated around.

So that's really important and so I think the debate is still out around kind of what is the grand fix in the standards arena. But I think it's really important also that there are other tools and I know that's not really -- your question was specific on the standards and completely understand that but there are other tools that have been very useful in industry for getting the right type of behaviors from inverters and they're working directly with vendors and manufacturers of these inverters -- have actually seen good performance.

The frequency calculation issue that was

described earlier today a good example of how in the second event that happened last year, we didn't see the frequency errors and that was because -- there was no standard that was implemented, you know, between one event and the other. Yeah, we saw good performance.

COMMISSIONER LAFLEUR: Yeah.

MR. MAURA: And I think that that's something we should really take benefit from and enjoy as an industry is that there are other processes. On the 1547 one, as Damir indicated, you know, very important that these smart inverters that we're not underutilizing their capabilities and I think the 1547 exposes a lot of that and allows utilities to set direction on how they want their inverters to behave and I think that's exactly what industry wanted and was a good compromise.

One of the things that I want to make sure you know, from a NERC standpoint is that if -- if there are issues or facilities or you know, things that are impacting the reliable operation of the bulk power system that NERC does have an ability to rectify that through whatever, means -- whatever tools we have.

So, you know, it's not like we would say well the 1547 standard fixes everything -- it's really, you know, working with 1547 and incorporating perhaps the standard within our standards of making sure that the standards on

the bulk system works well with the behaviors on the distribution system. They really tie in.

COMMISSIONER LAFLEUR: Yeah.

MR. MOURA: Right? I mean and one of the issues is that we had certain inverter standards or inverter designs on the bulk system and they were different -- I'm sorry, conventional generation was very different than the way the inverters acted on the distribution system and so you have the disconnect with kind of philosophies around ride through -- now they're aligned.

COMMISSONER LAFLEUR: Anyone else? Dr. Novasel?

MR. NOVASEL: I can't wait to talk, but this is excellent. John explained it really well. I would just like a couple of points here. Let's say 1547 standard does define all the ERS requirements. I mean for frequency response, ramping, what it supports is already defined.

But as for discussing the first panel this morning it's as base. How are we going to implement this now it's up to the other states or users or however it's managed, okay -- that's one element.

And Joe mentioned this -- what happened at this event in 2016 with 1300 I believe megawatts that was -- because there was a fault on the transmission system that caused 1300 megawatts on the distribution system on the PUV's to be tripped okay?

And we talked about this event -- the issue was that the inverters tripped immediately and waiting and again it was a thing that it was a great program by NERC and all the other stakeholders and all to fix it.

But also, this other element that occurred was that inverters thought it was a frequency event not a voltage event. So standard has a voltage right through so if -- actually the vendors follow the standards because they have the voltage retro capabilities and it was low-voltage.

But then the measurement was wrong so they implemented the algorithm that was wrong. So the algorithm basically it was zero across -- I'm a real geek now. So it was zero across the detector, it was not a reliable measurement and it showed that there was a frequency.

So standard cannot fix that. There is no standard that can fix that if the measurement is wrong. But one element that I really want is testing. I think it's very important as we go and implement this technology that we test.

So those are not all the standards you have if they don't perform up to the standards, so naturally -- the other thing I want to add is we actually have our MOU with NERC. And it's exactly what Joe was talking about. You are looking out to be proactive.

You know we said the reliability of this system

is good and all but you want to look ahead. You want to see what other professional issues that are coming up with a high penetration of renewable -- so we actually created the working group that put this on a fast track that is working together with NERC that was addressing impact of inverter based resources of dynamics and the short circuit currents.

So you may not have those issues at this point in time as much -- like short circuit current levels. And why is it important is because it effects protection of this system? If protection doesn't work you may have some in separations and you may have some reliability issues.

So together with NERC we did this analysis so we now have the report that actually NERC would be using to look into what it needs for the standards. And maybe some NERC reliability standards coming out to the report -- I mean it's not to decide.

IEEE, you take the report and see are there needs for more industry standards related to this area? But again, this is that proactive step as approach going forward, thanks.

COMMISSIONER LAFLEUR: So IEEE writes the standards, that's very helpful that you give to the vendors right when you buy the equipment, yeah, Mr. Miller?

MR. MILLER: I know I sound like a broken record but again this is another place for to be careful about

being too prescriptive, so -- and there's good, U.S. practice you know, for example, we've never dictated exactly how excitation systems and governors and things like beyond for example, droops and dead bands, but kind of minimal control things and that practice has served us well.

One of the things that I just wanted -- it was in my testimony, I just want to beat on this drum a little bit. It is from the -- from blue cut and events in other parts of the world with multiple faults.

So we're kind of as an industry synchronous machines have -- we've never had N minus 1 minus 1 minus 1 minus 1 minus 1 minus 1 - type standards when the little synchronous machines ran through and now we've seen some events.

We want to be real careful if we do come up with moving in the direction of inverter-based -- that they're reasonable and I specifically singled out the new Australian standard as being unreasonable and we don't want to go in that route and yet you would have an expectation of resources being able to handle a multiplicity of small events.

So the question is what's small and where's the threshold that it's going to be a solemn and level trait of wisdom and I think the answer to that is not be too prescriptive.

COMMISSONER LAFLEUR: Whether it's through standards which are clearly not the only answer, or our putting requirements on the interconnections agreements like frequency, like voltage ride-through or you know, the engineers getting together and working on the equipment standards, do you see in this area more -- I mean kind of like current is current and it's going to be the same whether it's Australia or Ontario, or North Carolina or do you think we'll see more regional variations with all the different policy directions.

Because NERC has worked hard to get rid of the regional standards and now when I hear things like CAISO wanting the standing, I want to wait, are we going back toward different regions in different places or is this just electricity and it doesn't know what country it's in?

MR. BARTLETT: I'll go with that. I agree, I think it is electricity and it doesn't know where it's at. I think that -- and grids for the most part, most of them are on a very small island or a micro-grid. You know, we understand how they behave very, very well.

I might differ just a little bit with Mr. Miller with respect to -- I would never want to limit or be prescriptive about the creative things that could be done with inverters but I really do believe that across international boundaries we need to have a set of data that

we understand exactly how inverters work and exactly how a distributed generation is going to behave on our systems, so that we can take the next step and model it so we can take the next step as Professor said and vet our models and make sure that we can predict how the power system is going to work.

So what we have today is the gold standard with respect to reliability and nobody wants to move backwards from that so I guess maybe I'm just slightly more cautionary, but we need to have a minimum set of data and visibility to how those things are working I think to make the grid feel as it does today.

COMMISSIONER LAFLEUR: But is it the gold standard or is it like you know if you had a standard for your 747's and then how you're going to have these propeller planes that you might have different rules because different sizes or is it the gold standard in how it behaves?

MR. BARTLETT: No, I think the system that we have now that we enjoy our way of life is the gold standard. That's what I'm saying is I think there needs to be a subset of features where we have very strict definitions of an understanding of how these systems are going to operate.

You know, maybe it would be in my mind easier to understand if we said okay, everybody can now have a machine on that makes natural gas, but we don't know how fast, we

don't know how much, we don't know when it is going to happen on how to turn it off.

You know, that would not make sense to most people so we have got a few rules around that. Now, if you can have all kinds of additional fancy functions it would be wonderful but we need to know the basic behavior I think to orchestrate the entire grid and make it work effectively.

COMMISSIONER LAFLEUR: John?

MR. MOURA: If I can offer just a couple -- so it's even today you know, there -- even though there are, you know, the same standard you know for example, Bough 003 for frequency response up to disturbance, there are different requirements for each region -- each interconnection.

And at the interconnection level, definitely very important -- we are talking about interconnection issues here when inverters are you know, can we all be triggered simultaneous, can be tripped off simultaneously, frequency is kind of interconnection-wide phenomenon and as it relates to restoration, UFLS, UVLS coordination, you know, getting black star and kind of cranking paths, working with inverters -- it's absolutely necessary that those systems if it's two or three or even more systems, speak the same language and understand kind of what it is going to take to get a grid put back together.

I think there can feasibly be more flexibility if you're talking about, you know, an interconnection-wide standard if WECC wanted to do a standard because they were ready to do a standard. The western interconnection was ready to do a standard. Perhaps they're ready before the eastern interconnection as a whole.

COMMISSIONER LAFLEUR: That's even written in the statute right?

MR. MAURA: That's right, yes.

COMMISSIONER LAFLEUR: If a standard is for a whole interconnection you get more play or maybe it's something -- there's something special about a region that's a whole interconnection or whatever.

MR. MAURA: Now I would be more worried if you know, there was inverter standard in CIRC compared to you know, because they are the same interconnection.

COMMISSIONER LAFLEUR: Thank you very much.

COMMISSIONER CHATTERJEE: Thank you all. Mr. Bartlett, I think you may have touched on this a little bit when I unfortunately had to step out of the room for a moment but it was important enough in your prepared testimony that I wanted to follow-up.

You cited some concerns about the lack of broadband access and how that could hamper the integration of DER's in rural areas. I think some of the technical

aspects of DER integration are going to be challenging and I thought your testimony highlighted what's an interesting issue and I was just wondering if you could elaborate on what impacts you thought this might have on the ability to communicate with DER's, particularly sensitive to, you know, insuring access in rural communities.

MR. BARTLETT: Certainly Mr. Commissioner and I appreciate your asking that. We serve rural electric cooperatives so we serve 23 distribution centers in the Midwest. Obviously we are serving people in rural America compared to urban areas -- that was our mission in the very beginning.

We can manage the telecommunications across our transmission system and across our distribution systems when it comes to be able to being able to create value for these people who generally pay higher electric bills because of the low density and are also probably the likely landing zone for most of distributed generation or a lot of it because of the real estate that's out there.

We have some real problems with integrating that in our systems and we can't have bi-directional communications. So bottom line is we've got large areas of our service territories which are drastically underserved with telecommunication. And right now we're having a hard time because we don't have parody in those areas -- seeing

how we get there from here.

But we really think that an overall part of the solution is going to have to be bringing up to parody the people in rural United States because they will be a source of a lot of this generation and we need to communicate with it for it to work effectively.

COMMISSIONER CHATTERJEE: Mr. Jones do you see similar circumstances in your service territory?

MR. JONES: Yes we do, absolutely. You know and as well look at you know, just like you were talking about Jay in you know, North Carolina, we have a lot of rural parts of North Carolina that we've got municipalities that are serving customers and we don't have broadband.

And in North Carolina it's probably exacerbated a little bit by our North Carolina legislation that has been passed that actually prohibits municipalities from getting into the broadband business to be able to bring those services to our community.

So you know, it's an issue -- it's, whether it's kids, you know from education to jobs, being able to expand those businesses and bring those into our communities, a lack of broadband is a significant issue and we're a little bit in North Carolina unfortunately we're a little bit handcuffed even further, you know, beyond just the FCC and the abilities there with a lot of the telecom providers.

We've got another incremental hurdle we've got to overcome in North Carolina with our legislation.

COMMISSONER CHATTERJEE: Mr. Gregg it's been a while since I've been to Mississauga but is this an issue in Ontario as well?

MR. GREGG? Well it is. We've got vast amounts of rural territory in Ontario and building on what Jay said, already customers that are expensive to serve because of the density we're in more urban parts of the province we would count how many customers per pole, but up in the rural areas for counting how many poles per customer. And so the cost has already been an issue and then when you add on top of that the cost of providing broadband and the issue about who pays for it and the fairness of that it's something that needs to be dealt with.

I think it's an important issue but we're already seeing huge cost pressures in Ontario as a result of policy directions we've had around renewable energy but also in terms of the telecommunications infrastructure to support it.

COMMISSIONER CHATTERJEE: Thank you all for that. Mr. Miller, in your written testimony you noted your concern about under-frequency load shedding potentially not being a useful safety net anymore given the proliferation of DER's and other changes. Could you just elaborate on that concern

and what, if anything, should be done about it?

MR. MILLER: Yeah thanks, and that's a pretty controversial thing to have said so I suspect I've got a few people's nose wrinkled with that. You know as inverter based resources become more widespread and they're -- at least the current occurring inevitabilities is that there'll be at least periods of time during the operating season when you're -- when we're at quite low inertia.

The time available for UFLS to act is getting shorter and shorter and that is one of the big arguments in favor of maintaining inertia. You said, look, this is a little bit circular in the sense that under-frequency load shedding, yes, has served us very well for decades but now we're talking about DER and under-frequency load shedding now doesn't want to disconnect those distributed resources.

We've also been talking about layers of additional awareness, communications and all the other things. Those have to be a piece of the protective strategy of the belts and suspenders that is today under-frequency load shedding. We've got to start thinking about that now. We aren't there, but as I said in my testimony, the writing's on the wall that under-frequency load shedding is the last bastian of simple and effective historical is now becoming obsolete.

And there's a bunch of pieces that fit into the

things you've heard from the other panelists here in terms of awareness, you know, what is the load really doing, what fractions of the load are truly essential? What fractions of the load are negative because they're producing?

And get ready based on big data, situational awareness to be able to take fast actions and it drives some of this question about the band width of these infrastructures. Are we really talking about stuff that can act in a couple hundred milliseconds that adds costs, but ultimately that's something that we should be thinking about now.

I don't want to go 15 years down the road and say we've got all this communication in here and it doesn't have sufficient bandwidth to meet these reliability needs -- so that's the reason why I raised the point now, and I think we have a chance to get in front of it.

COMMISSIONER CHATTERJEE: I appreciate you flagging, it. Dr. Novosel?

MR. NOVOSEL: Yeah, actually incidentally you know the report that I talked about -- impact of inverter based generation -- one system that managed it -- did for NERC addresses this exact issue. I have an extra picture here that shows how the frequency behaves at various levels of penetration of renewable generation, inverter based generation.

So -- but transfer on the solution side -- there is an issue. Frequency, as we said, Nicholas mentioned you know goes much faster than before and then the second stuff on the frequency issue has to be coordinated with this.

But of course there are professional solutions for this. We talked about inverter based generation actually having the possibility to react very fast. So if you have some head room, you can actually use that head room to address this issue.

The other aspect would be storage -- to be able to also, because storage can react very fast, can address this. So in business discussion with NERC we address this proactively, some of these issues ahead of time and now we're in the situation that actually we can take actions and address them.

So I just want to emphasize there is a technical solution to those problems. Those are not the problems that cannot be solved.

MR. MILLER: Just to chime in on that, I utterly agree and as you probably know I've been working on many of those controls and a lot of them are commercial. Remember these things are not, you know, wouldn't it be nice if such a thing were available. A lot of this stuff is commercially available today from my old employer for example.

Really -- but I was drilling in very specifically

on the under-frequency load shedding as at some point the other things fail, right? You didn't have enough primary, you didn't have enough resting energy. The event was three times as big as your design basis event -- these things happen.

And the industry is very -- I don't want to say very comfortable but is accustomed to having the last line of defense -- the under-frequency load shedding and say you know, and this is where I'm objecting to some extent -- and therefore we need "X" amount of inertia because the under-frequency load shedding can't be made fast enough.

So that's -- you're working back from a boundary condition that you don't need to live with.

COMMISSIONER CHATTERJEE: Anyone else have comments on that? Yes, sir?

MR. BARTLETT: I'll try to go very quickly because I'm going to pile on with what Mr. Miller said here but I think the technology that we employ today is a great back stop under the conditions I think Mr. Miller described, we'll never get there. The problem will be gone, you know, before we had any chance to fix it with load shedding.

The positive thing about this is we have the technology right now to use a much smaller hammer to fix problems like this with intelligence, with deterministic

high-speed communication. I don't want to keep ringing that bell but life could get better under these circumstances than what it is right now.

COMMISSIONER CHATTERJEE: Scalpel.

MR. BARTLETT: Exactly.

COMMISSIONER CHATTERJEE: Thank you very much for that. Mr. Miller, if you'll bear with me I'd like to get a little bit deeper down in the weeds. That's the problem with going last, you know, the subject matter's been covered. In your prepared testimony I saw that you were touting the potential cost savings from using remedial action schemes.

The increased use of remedial action schemes -- do you have any concern that we're going to be making the system so complex that we can't actually anticipate its response, particularly during unusual system conditions?

MR. MILLER: Yeah.

COMMISSIONER CHATTERJEE: Thank you for the elaboration.

MR. MILLER: Yeah and that's the reason why and I was picking on New England because ISO New England really hates their SPS's and are doing everything they can to get rid of them. In WECC there's a pile of them because they absolutely can't afford to operate the western system without some of those so there's kind of two schools.

My point is that the concerns that ISO New England about them being too complicated, unmanageable, you know, Joe Blissficta knew how it worked -- retired, but all of those things, those are absolutely real but those are institutional you know, philosophical human things that can be dealt with.

There are new layers of technology out there that are, you know, triply redundant, cyber secure, multiple physical locations for computing so that these SPS's aren't one of's that are floating around and this one got invented for this purpose and this got invested for this purpose and this one was sourced from a manufacturer with two letters and this was from three letters and nobody knows how they fit together. We can't do that.

But that, in my opinion, is not a reason to say we don't do this. This is the era of big communication, big data, big awareness and there's so much benefit for certain classes of SPS's as opposed to kind of traditional autonomous distributed response that we're going to have to go there.

And the Australia -- why do I keep picking Australia, because I did some work there. They needed an SPS and the system went black because they overloaded the last tie line and you know, we're going to need more of those.

But we can't do it the way we've always done New England and other's complaints about that and your point was spot on.

COMMISSIONER CHATTERJEE: Thank you for that. Bringing it back to storage -- I thought the discussion today has been fantastic. You know I'm very proud of the energy storage has been a priority since joining the Commission and you guys really touched on you know, the opportunities and the benefits from storage that will come as we continue to integrate it.

I'm just wondering if there's anything else you think the Commission can be doing to further the role of storage or reduce some of the remaining barriers to entry?

MR. MOURA: Well we looked at it -- good question from a barrier standpoint. I mean we've looked at it from a NERC standards perspective and again being very fuel agnostic and technology neutral, we haven't found anything in the standards that would be a barrier.

We're certainly not -- because we're fuel neutral we're not an advocate for any particular technology by default but there's nothing in the NERC standards that would prohibit its use.

COMMISSIONER CHATTERJEE: So to follow-up on that and you sort of touched on this just talking sort of back and forth to Commissioner LaFleur but just to drill down --

do you think any changes are needed to the existing NERC standards to facilitate communication and coordination between these new groups in the planning process or are the existing processes sufficient?

MR. MOURA: Yeah, no I think that there is opportunity -- always opportunity to improve, you know, whether it be the standards or the guidelines or technical material that goes into understanding new rules or mechanisms or risks and so there's always the opportunity for that.

Again, we would, you know, the advice that I've heard consistently from Nick Miller is don't be over prescriptive and let's be broad enough and remember that you know, these storage devices -- it's kind of like the fuel in a sense that you know, there's a batter or pump storage or whatever it may be then there's an inverter that's connected to the grid.

And so it really is about the technology of the inverters and how that integrates and works with the rest of the grid. At the same time there is an onus on the transmission owner and operator to insure it knows what they are connecting to their system and that it behaves according to certain responsibilities that they have.

MR. NOVOSEL: If I can just add that I think John, to your point, you need to start incorporating storage

into the regular planning procedures. I think it hasn't been done yet. I think that would be the next step. SVR, you know, doing load forecasting now or PV forecasting to do the planning -- I think storage is the next step that our planning tools need to have that capability.

MR. JONES: I just want to add that you know, to specifically answer your question I don't think that we need another standard for storage at this time. I'm going to tell you as I listened to this conversation earlier that took place between John and Dr. Novosel -- and by the way we're both from North Carolina so we probably have the same accent, you probably have noticed that.

You know, just listening to that dialogue that took place between these two gentlemen, you know, in talking about the inverters and then some of the other things that can be done. So I think as you think about, you know, you think about NERC in its role. You've got the FERC as policymakers.

Our markets, our ISO, RTO's and then the market participants and then the vendors -- I mean when you bring that collective group together, solve problems, you know get some of the design standards pushed upstream into the manufacturers, that's -- it's much more efficient to work on it there once, so that everything coming down the assembly line has that standard, you know, from a manufacturing

perspective, not from a compliance perspective on the back end.

So let's go upstream and solve the problem there so we don't have to deal with it downstream.

COMMISSIONER CHATTERJEE: Well thank you all. We've still got about 10 minutes left and then a break before our next session and I think with this distinguished group of panelists I'd hate to cut it short and so I think I want to turn it over to the senior staff to see if you guys have any additional questions or comments?

MR. ORTIZ: Very good, thank you, thank you Commissioner Chatterjee. I want to turn actually to one of the questions that's in the agenda and it goes specifically and a lot of you have discussed it. It has to do with the need for measurement and control of the system -- you know the power system as it exists in textbooks is a large, spinning machine -- there's essentially a second order differential equation that defines it and that's why we have under fixed load shedding at certain time constants, and things like that.

But we've heard that there are tons of opportunities now for advanced high-speed communications and a lot of advanced modeling to do new things. And so along those lines I want to understand, you know, in your experiences what have you learned in terms of

communications, in terms of either good lessons or bad lessons regarding those systems and how robust those systems need to be to support your activities?

What grid sensing technologies you've used and what applications you have used or you would like to see that would help to integrate better these new technologies and also be able to extract some of the benefits that we've been hypothesizing in this discussion.

MR. BARTLETT: I'll start that. The technologies that we've been using has probably been moving along with more intelligent relays so our protection systems have got fantastic capabilities of measuring, logging and taking action on a wide variety of things that happen on the power system -- whether it comes from a rotating resource or an inverter-based resource.

What we have found is when we added telecom to layer one, it's been extraordinarily robust and of course telecommunication -- something with carrier current has been for decades part of the power system but with new high-speed communications we could move away from distance protection for instance on our transmission lines to differential protection because we could talk fast enough that we can with certainty say this breaker will open in three cycles, or half a cycle, or whatever we need to.

That improved reliability and grew power quality

for so many of our customers I think it's dramatic. I think it's robust and I think it's absolutely where we need to place investment and time and concentration on because it will enable things we've never thought of before.

MR. MILLER: I have a comment on that that sort of fits with the SPS as well so that with better communications there's latitude now for -- and this is something we've been waiting for decades right -- for the PMU's to actually be useful for something, he says -- right?

But the -- with good communications we spent a lot of time today talking about sort of these extreme resilience-type things, the system breaking up when it's at N minus 4 instead of N minus 1 or something really bad happen.

The communications and the phase stuff have a role in that and for example in the U.K. they have a prototype now -- phase of betterment phase system that has got some brains to understand how the system is breaking up so when something really bad happens and chunks of the U.K. grid break off, they can detect where the breaks are and use some of this other smart communication to try to make the pieces be viable.

So that kind of fits in this world where we're trying to look farther than just N minus 1 so I think that's an important piece.

MR. GREGG: The only thing I would add to that is that what I think about in the future -- if we think how our systems are becoming more complex and they're only going to become more complex. I think our challenge is sort of how do we better leverage the data that we're creating?

We're in a regime we've got 4 and million smart feeders connected to every home in the Provence of Ontario. We've got an internet of things with connected devices -- DERs all around the system -- it's all gathering data. And we're only barely scratching the surface of that data.

And so I think that's a real challenge for us is to figure out how to actually access, interpret, analyze and use that data and I think it's going to be tools like artificial intelligence and machine learning solutions that are actually going to help us manage the grid because I think it is probably goes beyond the human control operator in the control room -- their ability to actually manage.

MR. NOVASEL: I actually just want to comment Dave Ortiz, Alison Silverstein and I wrote a short paper about 3 or 4 years ago about benefits of sychrophaser measurements just to reference. And I do want to comment that there have actually have been some applications of sychrophasers that have been very useful.

Again, I was at ISO New England just last week. They're using very effective identified installations and

what the source of installation is so they can actually pinpoint to the generator to correct those issues. The event analysis grid modeling special dynamic models and all -- so there's been lots of application.

Of course I agree that there are lots of new applications to be done. For those who see deployment and distribution at FERC -- San Diego Gas and Electric for example has the high impedance vote or falling conductor detection. That's a huge issue now especially with the fires. You have a falling conductor, you know, that can create the fire. So to be able to actually detect there is a line broke before the line hits the ground.

But to Jay's point and Roy's point requires lots of communications to implement. So it's in a pilot phase with San Diego Gas and Electric but again, technology -- this type of technology actually has again at present application and has still lots of new potential applications.

MR. MOURA: I think the panelists mentioned a couple of newer technologies very well for measurement. So PM used -- and we'll definitely put it out there, don't give up on them yet. And protection -- I think is really a big one. If we're thinking about you know, a system that does have a lot less natural inertia so actually inertia, not the synthetic inertia.

I think the clearing time has just become so quick that decisions, protection actions need to be taken in much quicker time and horizon so technology is like a traveling wave technology to be able to sense fault current in advance and understand the implications to its own protection.

Those have some merit in looking at that again, under this near system where the system is actually a lot less lighter.

MR. MCCLELLAND: I guess I'd like to pick up on the telecom issue. So as we consider the complexity and especially John your last point about the relays and the operational speed necessary for a system with lower inertia, the question I have is sort of the new interdependency that we've created with telecom and I think Mr. Bartlett, you in your written comments you said that the bandwidth limitations can be an issue so I guess my question would be how do we account for this new interdependency as it becomes critical to the operation of the grid so we'll have to have this interconnectiveness.

How do we account for bandwidth limitations? And then thirdly, what's the lifecycle of this telecom equipment and how do we account for that from let's say a cost benefit analysis?

MR. BARTLETT: I think the lifespan has been

extraordinary. I think it's gone -- I've never been involved with putting in any fiber optic cable that's not still in service today, mine is quite gray.

And it's been very robust so I can't say that's been true of all our applications that I have been involved with but I think the lifecycle of to start with perhaps with the exception of some end use electronics that may fall back maybe to an 8 to 10 year lifespan, maybe 30 plus on the fiber optics.

So I think that that's not a difficult thing to account for and I think that we have many years to recover the costs that we invest in fiber optics. I think how do we account for bandwidth in general is a more difficult question for me.

One of the things that I find is that many of the last mile solutions that we encounter in rural areas are extremely bandwidth limited. There are essentially no bandwidth limitations on fiber deployment so for us for security reasons, for technology reasons, and for robustness we think right now we don't see anything that's a good alternative to fiber optic cable, but we think it's a very good and long-lived asset and we don't see if that level of technology or something similar to it is employed.

I don't think there are bandwidth limitations but that needs to be there.

MR. JONES: I think the other element to piggy back on that to kind of think of -- and I agree with you on your fiber statement but I think the other element you have to think of is kind of from a resiliency as we've talked about it on the power side.

You know as telecom becomes more and more a critical component then you have to make sure that you know, you bury as much of it as you can underground, what is overhead. You know, make sure you have redundant paths so that as we do become more and more depending on using fiber to give us that needed communication infrastructure to be able to make those decisions, we have got to make sure that we have got redundant paths that have been designed into the fiber system as well.

MR. ORTIZ: Yeah, thank you. I have one more question. We've been talking and I appreciate the panel -- across boundaries, right -- all the way from down to the customer to end use devices and load management all the way up to electrical generation. But with respect to our authorities, you know NERC standards apply to the bulk electric system which has a very specific definition and is fundamentally conceived around the big right?

And just as this panel has been focused on marshalling lots of smaller resources to accomplish broader reliability goals -- when is there going to be a need to

rethink what we mean by a bulk system -- not to say from a standards standpoint, but just from the standpoint of operating the transmission system that's able to serve customers in a reliable way?

And then at that point when do we start thinking about when standards apply or do not or when different kinds of standards -- say typically 1547 or various other standards fit together to create an overall system that allows for the appropriate development of the kinds of services we've been discussing as well as the appropriate accountability for the reliable operation?

MR. NOVOSEL: I would just like to emphasize one point -- a need for TMD planning. We been isolated, we have to keep planning, we do deep planning. How can we actually start doing more of the joint TMD planning and we see that impact or the fault on PV's and all like an example that shows that we need to be doing planning together.

So I think once we start doing this it will open the doors to actually look on how we really want to manage the bulk power system in a different fashion. Until we do that it's kind of difficult because you're kind of operating in that silo in a way.

I know it's not easy. I mean don't get me wrong, but it's something to look into how we can manage.

MR. MOURA: I would just offer David, you know,

you look at the statute right -- I mean users, owners and operators of the bulk power system is kind of in the NERC family to promote and maintain reliability.

And you know, I think we sometimes glance over the user part because DP's -- distribution providers are an inherent part of again that functional model, how we plan to operate the system and we do have a role to play in how they use the system.

And so I think it's -- you know, while you won't have you know, my roof top solar array as a, you know, registered GO, the DP I'm connected to does have to, you know, does have to meet some current requirements and may have other requirements in the future.

And as a user of that system and as a reliability kind of steward of the BPS I think we'd want that -- that there are some requirements in aggregate that those distribution systems need to maintain so they don't disrupt the bulk system reliability.

MR. BARTLETT: Mr. Ortiz, perhaps the only thing I would add to that is I think it's an outstanding question and an outstanding thing for us to be thinking about. I guess I'm probably not hugely concerned about when we'll have to do that because I think the math is going to show very clearly when we need to do that.

So we have you know, very accurate modeling tools

right now and we can predict the behavior of the bulk electric system. As soon as our models start failing to predict the operation of the bulk power system, we'll know we need to take the next step and look in other areas. I don't know if anybody else wants to comment on that.

MR. NOVOSEL: Can I just add one more point. I need to mention electrical transportation -- there was a discussion on the previous panel. I think electrical transportation is hugely important for the society and it is going to affect how we manage the agreed on rule.

I think we should be really worried about this because first reaction is it is not going to happen overnight. You see in the system that load has been kind of stagnant or growing slow so I think as we are adding electrical transportation to the system we should be able to manage it as it is now.

And then do this planning and look into how the grid is going to be looking out and we have time to do it because not many cities will do like what Chuzanne did in China when they -- I don't have any busses or 3,000 busses or something they electrified, but of course that was a mandate from the top.

I think here in the states we really need to start promoting how important the ability of the cities for pollution. I always like to tell the story if you are let's

say -- wherever you are in the middle of the winter and it's cold and you have school kids running the bus -- busses running because of course the driver wants to keep the temperature in the bus, but then if it's not electrical you have this old exhaust coming out and the kids are passing by, they are inhaling that thing and all.

So we are not talking about global warming or anything, we're talking about the basic ability that electrical transportation can really enhance in our society. And it will change -- to your question, it was a great question, that will affect how we manage the overall system.

MR. MILLER: Just to chime in on that -- I agree, you'll see it, I still think that there's -- and maybe this is self-serving because I'm a retired researcher but there's a lot of room I think for us and DOE's done some good words coming out of the National Labs, to ask these questions looking forward, you know -- things like smart charging versus dumb charging right -- because they're really huge issues.

And if you really -- now would be a good time to figure out what kind of behaviors we really want from the integrated system and not a kind of -- we don't want to wait too long.

And one of my harping points is it is very

expensive to use the power system as a simulator. It's a lot better to run cases.

COMMISSONER CHATTERJEE: Well thank you very much for another fascinating discussion and panel. I appreciate all of you. We've gone a couple of minutes over and I want to stay as close to on-schedule as possible but I do want to extend everyone the opportunity to take a quick break, so why don't we reconvene promptly at 3:20, thank you.

(BREAK 3:07 p.m. - 3:20 p.m.)

PANEL IV: Addressing the Evolving Cybersecurity Threat

COMMISSIONER CHATTERJEE: Alright looking forward to our final panel of the day on the ever important topic of the evolving cybersecurity threat. Another fantastic group of panelists here to help us tackle this very critical issue and so we will in the interest of trying to finish on time, I'm going to dive right in and start with my questions.

I'll start with Bill Lawrence, I had a great visit to EI SAC a few weeks ago. I was very impressed by your team's use of the information provided by CRISP. And I was just hoping you could compare the analytical value of information from CRISP to the other reports you received from industry. Do they tend to be substitutes or more complimentary sources of information?

MR. LAWRENCE: Thank you Commissioner. We receive two different types of information at the ISAC. One

is voluntary information share and the other one is required reporting so we've got value from both of those streams coming in and we do see a complimentary analysis capability that we get from them. As you saw the anonymized capabilities that we were able to display to you and your staff on CRISP were giving us some insights, even in the unclassified space.

And the benefits again, CRISP, the Cyber Security Risk Information Sharing Program -- we are also partners with the Pacific Northwest National Laboratory and the DOE through the intelligence community -- taking that information up to the high side, looking at over 35,000 classified indicators are compromised.

So it's a holistic public private partnership, CRISP is a voluntary program paid for by the members, but that helps us and we're bringing on other capabilities to that would definitely compliment CRISP as well.

So it's a great capability -- we're looking forward to expanding it with DOE's help over the next couple of years as well.

COMMISSONER CHATTERJEE: As a follow-up, are there ways to expand machine speed data sharing and you know, if so does that help provide actionable threat intelligence or does that just provide a deluge of data that may not be all that useful?

MR. LAWRENCE: Commissioner that's a great question too because there are recent media reports about the value of the some of the programs that are attempting to do just that. We are doing one for the electricity subsector called CASE, the Cybersecurity Automated Information Sharing System. This is a pilot project that should come into production towards the end of this year and it involves the electric utilities that use a technology based on the sticks and taxi capabilities of sharing information.

Whenever we start talking about machine speed and automated information sharing I always like to throw in HV in front of that -- that's human verified. Because right now we don't have the trust in any of the information shared to be able to apply it directly to production systems without awareness of all the, you know, consequences that it might have right in there.

So we don't have machine to machine yet. We're on a pathway towards that and I know DOE and the National Lab System, as well as some other federal funded research and development centers are working on trust models so you can separate the weed from the chow.

COMMISSONER CHATTERJEE: Do you want to expand on that or any of the other panelists are welcome to weigh in.

MS. HAWK: Yes, thank you for the opportunity to

speak with you today. And we support the private sector in building capacity to prepare for a cyber incident as well as to respond to the cyber incident which is directly resonant with the conversation of rapid sharing information.

We have our national laboratories are our strategic partners. We have ten of them that we're working with right now and some -- you just highlighted, some of them are working in that area. In particular, Idaho National Laboratory is looking at indicators of compromise that would be applicable to the IT side and then thinking were those -- what information in those indicators are compromised -- could be applicable to the operational technology side?

So as you know the operational technology are the networks and computers that move data and process data to manage, monitor, protect and control energy delivery. And so those systems are responsible for real time operations and have such have physical consequences should an adversary get a foothold on our systems and manipulate them maliciously.

COMMISSIONER CHATTERJEE: Anyone else have thoughts, Mr. Crist?

MR. CRIST: I can talk about some of the information sharing. I know Bill Lawrence and his team has been doing a great job on that. One thing is industry, you

know, we're always looking for those additional points of information to help us better protect the systems.

And, you know, as we talk about Department of Energy's building stuff up, the ESCC is working closely with other industry -- other federal partners as well for that sharing of information.

You know and as Bill brings up that machine to machine and that automated stuff, taking action on that -- that is one of those things that as the grid operates, you know, something that shuts down something is a little concerning but it is something we're hoping, you know, some day we can get to that to protect against those evolving threats that are coming along.

One thing, you know, we also -- Lincoln Electric System, we went down to Topeka, to their fusion center and utilized some of their tools as well. We participated in a CRISP light a few years ago which was trying to create another product there that was maybe more cost-effective for smaller utilities as well. So that's one thing -- there's a lot of tools we're trying to reach out and do a lot of that stuff.

The challenge there is when you get this information and it's in the classified space, it's you know, taking that action and doing stuff on it, so that's going to be something that as an industry we continue to try to work

through that in trying to develop other ways of using that information without going across those classified lines, and you know, we'll share it with other people too to make the grid more secure.

COMMISSIONER CHATTERJEE: Thank you, along those lines in your testimony you mentioned that -- along these lines, the need to move to more robust framework that provides flexibility and adaptability to meet security needs. Could you elaborate on what changes will be necessary to the CIP standards to reach this end state?

MR. CRIST: Yes, and this is one of those things where you know, the threats are constantly emerging and new ones are popping up so there's a challenge when you're trying to build the standards to address what's there today and the threats of today and then you see something new coming tomorrow or something else pops up and trying to address those and balancing that out between compliance and security.

When there's something that's in the standards that require us to have in place and I referenced it a little bit but like malware protection and our protection against that and maybe that vendor is compromised or there's something going on there that we have concerns with that vendor.

We're now struggling with do you take that

software out of the system and risk the compliance violation or do you leave the system in place to be compliant but there could be the security threat out there.

So that's one of the those things that have given us, you know, more flexibility in the standards to even leverage some of the newer emerging technologies without having to say, "Well it'd sure be great if we could use this but we'll have a challenge with the standards."

Virtualization is one of those examples. You know when you talk about resiliency earlier on and I've talked with some industry participants that virtualization in their SCATA environment, SCATA alone, it gives them a lot of resiliency because they can build these systems up at multiple locations to defend against a single either physical attack or something in that system right there at their local facility.

Even from our perspective you know, virtualization you kind of save on that footprint of the servers and be able to put that stuff in place, but when you challenge or put that up against the NERC standards as they are today, as you know the drafting team is trying to come up with some new approaches to that to address that and that's where we get kind of caught with some of those standards saying, "Well, it wasn't really designed for this new technology, where are we going to go in the future?"

And you know, cloud is another thing I've heard multiple conversations on that as well is you know, cloud is out there people are using it. It's probably something that we're going to have to leverage for when you look at some of the grid monitorization and the electrification, communicating with these devices that are in customer's homes and out there in the grid -- micro-grids and stuff like that.

So the standards again to have the framework and I think as Commissioner LaFleur brought up you know it's a baseline, it's something that we want to go to and we have to have but yet we've got to have that flexibility on them so we can use those new technologies to defend against the emerging threats.

COMMISSIONER CHATTERJEE: I really appreciate that. You unpacked a lot there, do others want to touch on some of the issues you brought up?

MR. RATHBUN: Thank you Commissioner and thank you for inviting Microsoft to be here today. I completely agree with the need for flexibility on emerging technologies and the flexibility in frameworks themselves.

We would have a couple of recommendations. One would be from a framework standpoint there are a lot of actually already developed, pretty matures run by Mist for example, the fed ramp example of managing for civilian

governments, any clouds, sort of architecture -- being able to leverage that reciprocity with those which enable you to take advantage of new technology.

The other thing that I would recommend having spent a lot of time in the framework world and dealing with emerging technologies and threats is even those don't necessarily evolve fast enough to be able to take advantage. And so that there are emerging architecture standards coming out of the DOD and out of DHS called DOD, cybersecurity architecture review, DOD car and gov car out of DHS which is the government cybersecurity architecture review which flips sort of the paradigm on its head -- instead of trying to create a set of best practices and then figure out how do I map these best practices into my existing organization.

We look at the effects of what an adversary is try to do so we know the methods of their attack, we know the stages of their attack. We know the indicators of their threat actions and then we focus on capabilities to disrupt those. So how can I prevent them from achieving the goal that they want to do?

The advantage of that is it allows me to become a lot more focused on my specific industry and my unique risk threat. It also allows me to focus on new emerging threats because I can just simply add to that set of standards and think about capabilities instead of waiting three years for

academics to write me some best practices, right that I have to decide how to follow.

The last thing that it really lets us do is we can start getting true quantitative analysis of the effectiveness of our cyber security because I'm now really measuring discrete actions that an adversary might take. I can see where they're happening. I can measure my capability of acting against those and then when I really get to modern monitoring I can start sending synthetic transactions so fake transactions through those capabilities where I should expect a given result.

And if that result isn't happening, now I can see in context overall against my whole cybersecurity posture what might be happening with the indication of -- there's a compromised malware, well what does that mean for my overall cybersecurity if I lose that capability?

Is there a clear line that allows compromise or do I have other gates in the way? I can test those things real time and answer that question about is security or compliance more valued?

COMMISSIONER CHATTERJEE: Are there things that this Commission can be doing or should be doing to better enable the accommodation of the increased use of cloud computing technology in modern utility operations?

MR. RATHBUN: Absolutely. I think some clear

guidance to NERC on the need to establish or modernize the sub-standards or grant reciprocity with other existing standards so the utility companies can move out. It's also the kind of thing where organizations like Microsoft are happy to partner in pilots.

We actually have existing pilots going on with some energy grid organizations to figure out how to do that specifically in the cloud so we can find those unique nuances. We've done that with several other government and industry entities -- happy to do that for working with either NERC or FERC as well.

MS. HAWK: Thank you. Additionally, flexibility in rate recovery would be able to, you know, provide incentive rate structures that encourage the deployment of cybersecurity measures as well as physical security measures -- that's one suggestion.

And if I may speak to the emerging technologies -- as my colleagues have so clearly articulated, we need to bring cybersecurity in with the new technologies that are coming into the power grid. It's an opportunity for innovation so we can use the greater efficiencies and the greater reliability or resilience that these new power system technologies are providing and at the same time bring cybersecurity in with them and it will allow us to innovate the virtualizations.

So we have some work going on at Sandia National Labs where they're looking at containerizing power system applications so each application aligns within its own container. It's being given everything that it needs, decreases the chance it could be compromised. Were it to be compromised you just move it out and move the other container in. The rest of the system is protected so no calls -- no system calls for instance because everything is where it needs to be.

That is one example. We also have work going on with protecting access to the cloud for grid edge devices and backing up the higher view, we've been working with the energy sector since the early 2000's and the vision since that time and still today are resilient energy delivery systems that are designed from the beginning, installed, operated and maintained to survive a cyberattack.

So the idea is that these systems will be able to adapt to survive. And just following up on the idea that we're working in the operational technology space and the extent to which we look at IT is thinking about how it can affect OT -- that's where we are.

And in this space I think it's important to recognize that we actually have an advantage for the cyber defender should we leverage the characteristics of that operational environment affectively. Here's an example.

Each component in the entire system is designed to perform a very specific limited function. So we have developed technology that will allow the system to deny by default any unexpected cyber activity -- so that's communications, that's ports, that's protocols, that's processes -- if it's not expected don't allow it.

An example of that technology is a software defined network approach that it tailored to the OT system. So when you hear about SDN typically you're thinking IT and in the IT world as SDN can bring in a lot of flexibility, think of plug and play. Thinking, you know, adapt the network behavior to users requiring different capabilities from that network.

The OT version of that instead of plug and play, you're looking at deny by default. So lock the system down, shrink that cyberattack surface drastically by only allowing it to do what it is intended to do.

And then the next step is well what if an adversary were to attempt to use these systems and devices in the way that they were intended and designed to be used? So play by the rules, then what?

So we have technology that we've developed that would allow protective relay for instance upon receiving a command to very quickly use a physics model of the grid well within the four milliseconds that would be required for

response to not interrupt legitimate requests well within that time frame to work with its peer devices.

And ask the question -- if I were to execute this command would the grid remain stable or could it jeopardize stability? So there, even if the adversaries are playing by the rules, physics works and physics rules the OT space. So there -- I see a bright future to borrow a phrase from the earlier panel because we can use the characteristics of that operational environment to protect itself, to automate a response that makes sense.

When Bill mentions, you know, we have to be very careful about a machine to machine interaction without a human intervention -- yes. We'll bring the physics into it in this next generation of technology so that the system can adapt and survive.

MR. SRITAPAN: Thank you, so thank you for the opportunity to speak. So I represent Homeland Security in the science and technology record from the research side. So definitely on the emerging threats you're going to see, you know, there is an opportunity here when you think about, you know, how we would want to look at you know, peak times and how the power grid folks may consider what is it -- the power grid folks may consider leveraging like distributed energy resources and IOT energy devices.

When you think about these things, they do bring

in a new set of both capabilities in which we can see more visible as far as what we can do and how we can strategize around that, but we also have to understand that's a new threat vector for us right?

So in the cases of on the research side, we see with sub-standards and other things, you know, yes I can see level 2 devices that provide a great strength and visibility there. But when we think about level 1 device's in this case like a PLC, that's not something that we're automatically going to take that information in.

There's great opportunity there when you can actually, as you mentioned, take the different types of indicators and actually make an informed decision early on in advance.

Other piece I know mentioned were gov car activity so if that is something desired I can tell you currently in spin 5 we are working on -- so cybersecurity architecture view, spin 5 covers mobility. It's traditionally meant for -- you think about cyber kill chain and the adversarial actions posted essentially posts exploitation and also covers a little bit of pre.

So based on a specific scenario you can go through and see what are the adversaries actions based on, you know, what capabilities are going to deploy all the way to exploitation. Once you look at that and you flip it, you

apply in ordering this for mobile is the various -- in this case mobile security technologies or different types of security technologies could apply and based on that you can define if I only employ this technology what are my gap areas right?

And so leveraging things like that could work, you don't necessarily have to rely on gov car with the methodology that's there, it's originally taken from DOD for nascar on the DOD side, so that is an area of which is a good opportunity to look at.

Well based on what technology, what gap area am I either filling or leaving open? That's a good opportunity. So other pieces we looked at is you know, and this applies both -- you know, on DHS, DOD side, and you can see that cybersecurity as we, you know, traditionally do it today, does need to evolve to the cyber physical systems resiliency.

You can think about Nist 800-160 Volume 2 as an example as that piece is where we want to be able to operate in either a compromised state or a denied state. You know, how are the systems actually going to interoperate and work, even when they are compromised -- those three pieces of which we see in the future going forward.

COMMISSIONER CHATTERJEE: Thank you very much for that. Pivoting a little bit -- I want to engage everybody.

Mr. Miller, in your written testimony you seem to suggest that perhaps government should leave the threat intelligence business to the private sector. Can you elaborate on that concern and how you delineate between what type of threat intelligence sharing is appropriate for government versus the private sector?

MR. MILLER: I believe I didn't say threat intelligence but services in general or at least services is where I'm going. So we certainly have other intelligence out there. The specific services that I was referring to are flyaway teams. We've absolutely lost business to the DHS who was able to do flyaway teams for the little, little price of free and we cannot compete with that.

We do bring in a certain level of capability that isn't necessarily provided by DHS as well. We have a strong expertise our customers rely on that and so those services and also potential areas where initially there was unique research done inside of potentially labs years ago. It doesn't necessarily always spin off into the private sector in a successful fashion or the private section does catch up eventually.

However, you do still have those competing odds at the end of the day.

COMMISSIONER CHATTERJEE: Bill or Vince, do you want to weigh in on this sort of balance between private and

government?

MR. LAWRENCE: Yeah, Commissioner I've seen a lot of success with public private partnerships. We do have relationships with intelligence sources such as Dragos and others out there. And of course with government, the intelligence sources -- the government is the only -- has the capability of classifying information and it's invaluable to get you know, we could peel that hole on you about industry, classification and clearances and then also access to that data.

But it's where I think there's a healthy balance between what is provided by the government and then also, you know, picked up by industry to continue on because you know, capitalism works so in the end that helps settle out with the markets that we've seen.

MS. SCIARRONE: Commissioner if I may.

COMMISSIONER CHATTERJEE: Yes.

MS. SCIARRONE: Having served both in government and now being in the private sector, I think I have a unique view in this. And to go back to my fellow panelist from DOE who talked about having done this for quite some time.

In the 2000's I was in a little known office -- a critical infrastructure assurance office in Commerce, right, when we were addressing cybersecurity issues at the time. You know, we were coming out of Y2K and addressing code red

which is kind of sad when you realize that we're talking about those same things today that we were talking about in 2000 and yet that's basically where we are.

Like my colleague from DHS, I had the privilege of helping stand up that department and so seeing as we evolved the information sharing piece right, moving from PDD 63 under the Clinton Administration to really building up ISAC's and seeing how they get used and setting in place the sector coordinating councils.

And then I had the privilege of serving in the White House and working on offensive and defensive cyber policy. And so now going to the private sector, I can tell you that there is value in each of these, but what I think we really need to focus on is we've been sharing information for so long but it still doesn't seem to be working, right?

And not because it's not valuable and not because we're not trying, but I think we really need to focus on making sure that the information we are sharing is actionable, but also actionable and appropriate for who's receiving it right?

So you can share just hashes and IP addresses for someone to block, but if you're not giving the context of why they should be doing this or how the threats evolving or explaining to them how the threats to their IT system are now making their way to their OT system, or how someone who

has devices that quite frankly need to run on Windows XP and telling them to patch it is not an option -- give them some other ways to help address this right?

So our panelists have talked about flexibility and how important that is and I can't agree more. But I would say I do think this needs to be a partnership around how do we provide really, actionable information, very tailored information that people can take action on, but also let's make sure we're not forgetting the adversary.

So if you look within the standards and they are a fantastic framework and I will say regulatory bodies are by design ponderous and are meant to be and that's a good thing. The standards give guidelines but not once do they mention adversary, bad guy right? Who is attacking your network?

And if we looked at DOD and said you need to prepare for wars but we're not going to talk about who you are fighting against, people would think that's absurd. And so as we look on taking in these standards and it's been recommended that you take in some of the NIS standards, the existing standards, I would just encourage you to also focus on the adversary as part of that and make sure you fully understand the threat you are seeking to address.

COMMISSIONER CHATTERJEE: I appreciate that and I appreciate your perspective having been on all side of it.

MS. SCIARRONE: All sides.

COMMISSIONER CHATTERJEE: Thank you, with that I will turn things over to Commissioner LaFleur.

COMMISSONER LAFLEUR: Thank you very much for all of those thoughts. I wanted to pick up on some of that conversation especially Commissioner Chatterjee's exchange with Mr. Crist on as I've been asking all day -- the current state of the standards and you know, Miss Sciarrone just made a comment on how much they call out the adversaries and how they're geared, but we've heard -- this morning we heard that the standards were just a baseline and any self-respecting company has gone well beyond that.

However, in other parts of our life we hear all the time they're way too restrictive and they should be cut back. Earlier this year when we had no quorum, or maybe that was last year -- the year's all blend together, EEI said we should have a moratorium on standards, there's too many and so I guess I'm just interested for those of you who are all in some piece of this world, what's the state of the CIP standards?

Because when people criticize the NERC standards as being too slow and don't respond to fast-acting threats, this is almost always where they're focusing in, yet it seems to be not just a necessary evil, but a critical part of the way we defend against this.

So what do you see the trajectory going forward of these and if you think we should be using other things, like NERC alerts, which we're seeing more and more of in this space, how do we make them actionable and make sure we have a feedback loop to make sure we're really doing something in, you know, addressing, just interested? Maybe starting with Mr. Crist because you I know are from a regulated -- a registered entity that has to deal in this space.

MR. CRIST: Yeah, I was trying to figure out how I got on the panel. So yeah, I guess it's -- one of the things when you talk about the NERC standards or the CIP standards, you know, one of the things they've been influx for quite a few years, you know, starting out with the urgent action and then moving all the way up through version 3, version 4 -- it never went into effect, version 5.

COMMISSIONER LAFLEUR: Isn't it inevitable because the threats keep changing?

MR. CRIST: They are and that's the challenge I guess because as an industry you're trying to get a lot of stuff put in place to deal with the new standard that's out there today. And when you're looking at some of the newer technologies like we were talking about earlier -- virtualization, those weren't even being thought about when

you know, the current version of the standards started going into being drafted and then voted on and off, you know, that process.

So having the framework, you know, like Matt mentioned here about fed ramp -- that's one thing that we are leading a team through the CIP C Committee and trying to figure out is there a way we can leverage the fed ramp model -- the framework, and match it up to CIP and have that assurance that we're compliant and that the auditors will agree to that.

COMMISSIONER LAFLEUR: I want to come back to the reciprocity. With your standards maybe I'm just getting fetchy from sitting here all day, I feel like there's a tension built in because every time we try to have, you know, we try to suggest a standard, we hear -- don't go so fast, be incremental, only start with the high impact assets, don't do the low, please take a separate step.

But then on the other sides of their mouth everyone is saying, how come they're changing so much? How come you keep going back? But that's kind of like built in to the process that we've built and the thought of just adopting reciprocity from some other you know, framework that's out there is of course sounds really appealing but aren't those evolving too? Aren't those maturity models and ramped models and all -- I mean is the creep just built into

the threat that we're addressing, or is it something we are doing in our mutual interactions that's making us have to keep going back over it? I guess that's --

MR. CRIST: Yeah and I guess that's one of those things that it's probably, you know, a struggle for all of us. Looking at that when we're trying to leverage stuff outside of the electric environment and when it's only the electric industry under the NERC CIP standards, when you talk to some of the vendors they're like -- I don't want anything to do with the CIP standards.

So we had challenges with even getting for personnel risk assessments as far as having the nuclear regulatory employees or people under NRC be able to work with the NERC CIP standards because we could not get information from NRC showing that they had a background check.

So those are the struggles that you probably don't hear about. It's like when we have those kinds of challenges from industry and you have the nuclear employees that need to go into the transmission owner's facilities to do their checks for that security.

Now they're saying you can't come in because you won't give us your personnel risk assessments -- a whole other issue but those are the things that you know, we struggle with and maybe, you know we need to have

conversations around them that's why I really appreciate this conversation.

COMMISSIONER LAFLEUR: Absolutely.

MR. CRIST: And you know, talking with several large vendors -- since Matt's here I'll bring that up as one too. Now they're saying, "Hey, we have the cloud, we have this great technology, we have this, you know, all this monitoring systems that we can put that are far better than a small company like we can do."

But I say well can you prove NERC CIP compliance to us? And they said well we meet all these other frameworks. We meet NIS, we do fed ramp, we do all this -- no you don't need NERC CIP, so --

COMMISSIONER LAFLEUR: Well what do you think would happen if you tried to take an industry vote to replace some piece of CIP with some other model, do you think it would pass or do you think people would say, I mean, I think people would say, "Whoa, we don't want that enforced, and you know."

MR. CRIST: Well and that's I know, I think you run into a lot of different scenarios and situations from utilities because everybody's got their own kind of unique way of operating in their systems, but with cybersecurity, you know, it crosses a lot of different boundaries, you know, speaking from my experience when you hire in

cybersecurity personnel, they are focused on either financial standards or stuff they've had to address there so now I'm having to train them on NERC CIP standards.

If you adopted those other frameworks, you know, they've got to take into account that operational technology because that is a, you know, different than most people. Like we were talking at lunch you're operating physical --

COMMISSIONER LAFLEUR: Not different for most people in the electric industry -- they're all operating.

MR. CRIST: Right.

COMMISSIONER LAFLEUR: I mean the CIP is just an overlay.

MR. CRIST: Right.

COMMISSIONER LAFLEUR: But underneath they're the wires and the plants and the --

MR. CRIST: Yep, and that's where you know, when you look at some of those other frameworks and stuff, there may be one that industry would adopt or come, you know, have a consensus on, but that's one of the things that you know -- I know industry has created these standards.

You know you kind of put them in and they get back and forth you know, with additional modifications. It's keeping up though as we're getting the new technology and some of the newer threats I guess, and I don't know if any other standards would say they're going to protect

against all future threats but it might be something that it's more accepted across different boundaries instead of saying here's the NERC CIP standards as a vendor and you need to meet these, and they're like -- no, we're not going to do this thing and we're not going to have staff that have to learn all of that.

So I think there's a little bit of a struggle there.

COMMISSIONER LAFLEUR: Do the -- are the NERC alerts useful?

MR. CRIST: Those, you know, they give us another point -- a measuring point of where they're at.

COMMISSIONER LAFLEUR: Faster to get out when something happens.

MR. CRIST: Faster to get out and you know, I think most people again I think like we were talking about or like what Neil mentioned, if we know what the threat is there and you know, that can somehow tie to that NERC alert action usually occurs very quickly. If you're just throwing --

COMMISSIONER LAFLEUR: You don't believe if it doesn't list the nation, state or something you just kind of think that maybe they are exaggerating -- I'm just asking, like if it comes it's all red with big red and green boxes and it looks very scary.

MR. CRIST: Yeah.

COMMISSONER LAFLEUR: But it doesn't say this country did this because that's not in the --

MR. CRIST: Right.

COMMISSIONER LAFLEUR: Unclassified --

MR. CRIST: And I guess that's one of those things that when we look at the secret versus top secret, you know, from my perspective, I don't -- I guess I don't care who's doing it. If there's something -- a threat out there, we're going to take action on it.

It could be somebody down the street doing something too, it's just something that if they're getting into our systems, we want them out of there. And that's a little bit of that challenge that we have is you get this information in classified briefing but you really can't take action because you can't give up the intelligence on that.

COMMISSIONER LAFLEUR: Yes.

MR. CRIST: So we're -- you know, --

COMMISSIONER LAFLEUR: Very familiar with that part of it.

MR. CRIST: You know that's a struggle but you know it's like the one alert that came out again about the software vendor, it's like thankfully we didn't have anything on our systems but other utilities that I talked to said this was right there, what can we do?

You know, we've got to meet the NERC CIP standards, but yet we need to try to remove the software. So you know, you get into this balancing act with that.

COMMISSIONER LAFLEUR: Who's -- like you're dying to add something. You have a smile and your nodding and --

MS. SCIARRONE: It's just a smile. No, I would just say Paul points out a lot of the practicalities right? And I often times find when people are talking about this we forget to be practical and it's about making sure you're focused on the outcomes right?

So regardless of what a standard is, I think we've all said across the board, let's focus on what is the outcome -- either the adversary or the security measures are trying to do. What do we want to do and why right? And balance that with the practical nature you asked about the nation state -- I joked, Ben may disagree.

It's helpful to know in broad category what we're talking about from the adversary but people spend a lot of time trying to pinpoint it all the way down to a specific person sitting in a specific location, behind a specific computer.

At the end of the day I think most of us that are operators care a lot less about that attribution piece and a lot more about what it is they're trying to do and how are they trying to do it so that their teams can help put in

place the best measure to try to protect against that.

COMMISSIONER LAFLEUR: So that's what you meant by knowing more about the adversary, not knowing who the adversary was, but what --

MS. SCIARRONE: What are they trying to accomplish and then how do I address that in a practice nature, right where I think we've talked about my colleague from DOE mentioned having flexibility in the rate recovery, right?

These organizations operate on small margins with a requirement to stay up for a certain amount of time for reliability and so the practice nature of being able to rip and replace things that are inherently insecure and replace them with newer, more secure technology becomes difficult at times and so --

COMMISSIONER LAFLEUR: I was going to ask about Dr. Hawk's comment because I feel like there's kind of an urban legend that a lot of people would like to do more in cybersecurity but they can't because of their rates and FERC should do something.

But I never talked to a transmission owner at least that doesn't have an opportunity to recover cybersecurity costs in their transmission formulary. So was it mostly generation we're worried about I mean because this is a thing where I frequently said like before podiums, if

there are rate issues that I'm not aware of please come and see me, but yet it's definitely said a lot so I want to give Dr. Hawk first and then others a chance what we should be doing to address if there are actual under recovery problems.

MS. HAWK: Well just in the sense of helping support deployment in cybersecurity measures that's you know what my comment was referring to.

COMMISSIONER LAFLEUR: What did you saw?

MS. HAWK: Just in the sense of helping the sector support deployment of cybersecurity measures and in terms of -- this is part of what we do in the SEDS division, the service initial liberty systems. And another way is we help support R&D, research and development for technologies that address the outcome, right -- that look to, look towards resilience instead of a reactive posture which I think is a very important distinction.

So we're looking to survive an attack, not to react to the latest threat or the latest vulnerability that's been disclosed but to survive which is a different thing.

COMMISSIONER LAFLEUR: We certainly share that goal and thought that was the purpose of the whole enterprise.

MS. HAWK: In terms of the economy of this at

this stage we find our energy sector defending itself against very sophisticated and highly targeted actors. So they are on the front lines of national security now and in order to reduce the business risk that they would otherwise have to experience were they to pursue R&D for technologies that would enable resilience, we have the program that cost shares.

So we fund folks to help you know, develop these resilient technologies. You bring up generators. One of the things that we have going on and is now being demonstrated is a machine learning approach for power plants to pull in. It's using machine learning, AI, pulling data, including the physical operating parameters, extract features from that dataset, look for excursions from that surface that would indicate a cyber intruder from an intelligent actor which puts it in a different category and then accommodate to survive -- figure out what parts of the system are still trustworthy, which ones may have been compromised use and remaining trustworthy parts of that system to continue delivering power while the adversary is being isolated and ejected.

And again, that can be done by just understanding how the system works and using that to the advantage of the cyber defender.

COMMISSIONER LAFLEUR: I mean I think the R&D

work that the Department of Energy and the labs do is very critical. Obviously the industry funds some through EPRI and others but if there are actually times when a company is wanting to do something on their system -- buy a new package or something so that you make it more secure and they're not able to fund that, I mean I think -- we would like to know about that because that's not -- you know, that's where we're actually getting into something we actually have.

There are so many things we can't control that are not within FERC's authority -- utility rates are one of the things we actually do. So I'll just say that. Yes, Bill?

MR. LAWRENCE: Commissioner if I could go back to your comments about the NERC alerts. That is definitely a very powerful tool and since the EI SAC is a division of NERC, we have access to that and provide subject matter expertise to the crafting of those.

Again, it's the delivery to process, we work closely with Director McClullen, FERC staff, industry input, to make sure that what comes out of that is actionable by industry because you know, heaven for fend, there is the level 3 option that could direct operational action on the grid.

We've also seen, you know, the evolution with the powers given to the Department of Energy by the Fast Act and

we've been able to include those in the scenarios that we use in Grid X. So going above the standards with the training that we can get out of the exercise, you know, alerts being a tool that we could use.

We also have something that's going to be more timely -- that we just operationalized this year called our critical broadcast program. We did that for an entity that had a cyber security issue with some malware earlier in February we were able to get thousands of people on a phone line to talk about what the implications were.

So we err towards the side of information sharing, timeliness as opposed to complete accuracy. And in reality you know there were three alerts last year that had ESI content in them. One of them, very pertinent to the recent discussion around the Russian threat -- we didn't name names, because you know, like Paul said they don't really care who's breaking in through the door, they just want to stop it and mitigate the circumstance.

But we are very tied to our close government partners so that we can develop things like the alert, unclassified, get those out, share in the classified space where we can, but get the actionable intelligence out there to the people that can actually be on the keyboard without the need to know the tactics and procedures to get that intelligence, so a very powerful tool kit we have.

COMMISSIONER LAFLEUR: Thank you. Mr. Lawrence, you're relatively new in your role at ISAC, am I crazy?

MR. LAWRENCE: I've been at NERC for 6 years and as the Director of the ISAC since April of 2017.

COMMISSIONER LAFLEUR: Okay, so okay, so that's longer. I thought it was this year. So I guess earlier today Jim Robb talked about the renaissance of the ESI SAC. I'm curious how you see that, you know what you see as you're major challenges, your goals.

It's even better now that you've been doing it more than a year as opposed to if it was April, 2018 as I mistakenly remembered.

MR. LAWRENCE: Well thank you. I'm definitely a beneficiary of some very hard work done at the electricity subsector coordinating council level. When that changed the current incarnation of 30 CEO's to include Jim Robb and Bill Furman as well as some other panelists. They took a hard look at the then ES ISAC and said we need this capability, you need to get better.

So they created the member executive committee that's co-chaired by Bill Fehrman and John McAvoy. They've been giving us very close oversight of how we are planning and we built the long-term strategic plan that was part of NERC's 2018 business plan and budget and now we're executing to that plan.

So we've had two quarters of performance under that and we're looking at like a five year mission from Star Trek to build out capability in terms of the team, our tools and the training that we have to make sure that we're an effective and valuable asset for all of our stakeholders across North America -- so Canada, U.S. and Mexico.

We're growing the team. It takes time, it takes money. We've had some really good successes recently with our HR hiring process and we're looking to have all of our 2018 roles filled and starting to look already at 2019 roles.

COMMISSIONER LAFLEUR: And you're a membership organization? I mean I --

MR. LAWRENCE: No, we are actually under NERC's budget.

COMMISSIONER LAFLEUR: Yes, but I mean people -- like I think I read in Mr. Rathbun's testimony that you chose not to join the ISAC, am I crazy?

MR. RATHBUN: I believe that is the case. I'm not a member of that, I think the actual -- we were attempting to partner so we have our own counterintelligence arm -- the Microsoft Threat Intelligence Center where we work with several different government entities.

We actually collect the world's largest threat

set or one of the world's largest sets of threat intelligence data from all of the different Microsoft installed devices around the planet -- billions of devices every single day talking to us.

And then we went and hired a bunch of cyber offensive operators from around the world who are really good at what they do. Then we look at that dataset and we look for the fingerprints and activities of our adversaries not attacking us.

So I process over 7 trillion events a day against Azure alone. But we're looking at those billions of devices every single -- around the world, looking for things happening like this looks like Helium which is the organization that attacked the DNC, acting on online banking in Sri Lanka.

And we can tell through various ways, the name processes, password sets that they use, other ways fingerprints and mistakes they make -- all humans make mistakes.

COMMISSIONER LAFLEUR: Anyone who has a Microsoft operating system, you have some -- so that's -- did you share that with Bill and say this is what we have.

MR. RATHBUN: Right, so one of the recommendations that we're making here in our proposal is to get Bill's organization tied into the Mystic team so that we

can share that data. We do share it with several other government entities and customers as needed.

What we looking for is not --

COMMISSIONER LAFLEUR: Who is a customer -- right, anyone, who doesn't right have Windows.

MR. RATHBUN: Yeah and so we're mostly doing it to protect ourselves. Most of what you see out there when you get past Tuesday updates and things like that is we've seen adversaries testing things in the wild and we've fixed ahead of time.

And if we'd identified that something is actually a failure on someone else's technology we inform the owner of that technology that we have found a cyber threat against them. If we are seeing it specifically against our customers we notify our customers and we let them know that there is a particular cyber threat.

If our customers detect as cyber threat against their infrastructure we can let them know whether or not there was a smoke attack or they just got caught up in something, you know, that was really targeted somewhere else or was a general broad sort of thing, so lots and lots of valuable intelligence data actually based here in D.C. that we can check.

MR. LAWRENCE: So when we talk about EI SAC members we focus the membership on our asset operators then

we do have partnerships and it is on our roadmap to get more involved with strategic vendor partnerships. We have had some initial discussions with Microsoft. It's a prioritization thing in terms of staff and resources to get these but we aren't ignoring the threat.

So one of the other alerts that was in 2017 was around the Malware discovered by folks from -- who did the research in the Ukraine on crash overwrite and destroyer. So we're particularly focused right now on things that can affect the operational technology side of the equation and as we, you know, built our portfolio, the vendors that can deliver visibility into both of those sides as well as analysis capability, we're focusing on that right now and definitely interested in what is seen across the world.

I would say that you know, the attacks in Ukraine we partner with the Department of Energy and we had some EI SAC personnel that were first-hand, you know, boots on the ground with that and we learned a lot from something that wasn't spread across the world. It was focused on specific systems to affect the electricity industry.

COMMISSIONER LAFLEUR: You're just putting that as an example. You communicated that through NERC alerts, right? I remember seeing that.

MR. LAWRENCE: Yes, that was a level 1 NERC alert that was shared very rapidly within a week of being notified

by our friends here from Dragos to getting something out from government informed additions that we could release with that alert. And then more information later that got declassified and available on our portal.

COMMISSIONER LAFLEUR: And is there any feedback loop of like whether people understood it or did anything or do you just assume in their self-interest they should read it and jump on it right away or --

MR. LAWRENCE: There is definitely a few back loop -- we've gotten good response when we talked about not only the alert but also the indicators are compromised on there and then we have, you know, another plethora of tools available to include monthly briefings where we get threat intelligence experts to come on from both industry and government talking about the specific mitigations to these threats and signs that you might have this threat affecting your systems.

So it's been a good loop there and then we also do an annual grid security conference that's coming up in October and we'll have experts talking about that as well as INL will be providing a cyber strike training session there and a bunch of other commercial vendors providing training to our members.

COMMISSIONER LAFLEUR: Thank you very much. I don't mean to be challenging it's just I've been at this a

long time. The idea of this CIP 1, CIP 2, CIP 3, CIP 4, CIP 5, it's like the IPhone -- what are we up to CIP 7 dash something, is to make it better.

We're really trying to you know have standards that actually help protect the bulk electric system and if there are things we should be doing differently that we have to flex our authority in some way to use reciprocity or get this statute changed or something, you know, this is a good chance to hear about them.

Because this is a thing we hear an awful lot of complaints about CIP, but yet it does seem like it's you know, it's not going to go away. This is part of our responsibility, it was directly in the 2005 Energy Policy Act it said FERC will put out standards to protect against a cybersecurity incident so we're, you know -- yes, Vincent?

MR. SRITAPAN: So Commissioner I will mention you know, the idea of using a threat framework to inform a standard is a good use but keep in mind you're not adopting the threat framework in substitute of anything right?

When you do create the standard, at least the way we've seen it is that if NIST is going to develop a standard for whatever the technology, whatever that may be of best practice, it's not necessarily has to be coupled with what adversarial actions are occurring.

You should take a threat framework, you know,

that may be applied to your sector and use that to identify well what best practices will I need to do in the standard so that I can cover the threat actions that are occurring.

Just knowing that you know, you can use one to inform the other that's helpful.

COMMISSONER LAFLEUR: Yes, Mr. Miller?

MR. MILLER: Hi, yeah so I want to go back to the original question that you had to Paul and then kind of I'll go back up to this conversation that we're having now. You were originally focused on standards and threats and so --

COMMISSIONER LAFLEUR: And are they working, are they -- where are they going?

MR. MILLER: Yes, so my answer is in the context of multiple roles so I was an asset owner, I was on the implementation team for CIP version 1, as well as version 2.

COMMISSIONER LAFLEUR: The daddy of them all.

MR. MILLER: After that I moved on to NERC. I worked closely with Bill at the electricity ISAC and so I saw from a different angle there and now I am a vendor and I work closely with my customers and some of those challenges there.

I will -- in the moving to the threat aspect, so going back to the 2009 or so when it was CIP version 1 or shortly thereafter, we were talking about Stuck's net. In 2010 we were talking about Stuck's net, in 2011 we were

talking about Stuck's net, in 2012 we were talking about Stuck's net and then we finally started getting to other use cases.

We saw Havox, we saw Black Energy 2 --

COMMISSIONER LAFLEUR: Saudi Aranco in those days too.

MR. MILLER: Sha-moon, certainly and then finally most recently Crash Override and then Trices, impacting safety systems. We can count on our one hand the number of attacks that have interrupted industrial processes or at least those that are known to be from a cyber means.

So our understanding of the threat is fairly limited. I mean we have anecdotes. We don't have large datasets so I think that's hard from a standards process to wrap on an anecdote basis to like chase the threat if you will.

However, that said, Dragos is tracking 8 activity groups. These are folks that have interesting critical infrastructure and industrial control systems or have the capability or have shown success in that.

However, the overlap of what they do during the attack sequence, that long duration -- because this isn't a short burn attack that is instant and suddenly powers out, this is a month long activity.

The tactics used by all of these activity groups

which are distinct activity groups have a large overlap. So understanding those methods and those tactics that they use in figuring out the crosswalk between them and the standards is probably the best use of resources which goes back to the rate recovery which I am not an expert in at all.

However, I can say the challenges of our customers are not in deploying new technologies and doing more protections, it is on maintaining and operating those over a long run. So having personnel to support and actually defend the systems that they've already deployed out there to protect, that is their challenge that they're having today.

COMMISSIONER LAFLEUR: That's very helpful, but even as we get all those new threats, we go from Struck net to the next one, aren't the standards more basic hygiene? Like are you ever going to regret requiring password protection and secure communications and firewalls or, do you know what I mean?

They're not -- there are kind of no regrets. All hazards, basic I thought not like oh a new thing happened so we needed a new standard today.

MR. MILLER: I think during the implementation it becomes challenging when you decide from a compliance perspective that your PSP can't be your data center so you're installing five walls around racks and investing

money on that aspect, rather than investing it into improved fire wall systems or other defensive systems.

COMMISSIONER LAFLEUR: So when these people spend money in the wrong place?

MR. MILLER: In that they're -- it becomes a struggle to allocate resources appropriately when you're looking at the risk -- the security risk versus a compliance risk during implementation it can be challenging to not pursue the compliance risk and then do the security risk.

COMMISSIONER LAFLEUR: Mr. Rathbun?

MR. RATHBUN: Yes, you asked at the beginning if the reason why the CIPS couldn't keep up is because the threat is evolving -- it's not just the threat it's the technology itself is evolving.

And even to your question there hinting that, well shouldn't we always have firewalls? The answer is actually not we should always have firewalls -- there are certain pieces of technology where we have evolved so far beyond then that it's less secure to use those older paradigms and that's one of the problems with ponderous regulation growth is it's very, very difficult to keep up with, especially if the regulation requires a specific implementation as opposed to what Miss Sciarrone said which is I think the correct idea, an outcome.

What we care about is can we prevent someone from entering into our secured enclave -- whether that's a fire wall or any other technology. Maybe it can be purely identity based. I shouldn't care about the method in which you arrived at that outcome, I should just care that you arrived at that outcome and that you're capable of demonstrating, and proving that you've arrived at the outcome.

And I think the other question about whether or not the CIP standards would allow you to do that give you that flexibility and Mr. Crist said it very clearly, no vendor will tell him yes, I can do this. I have 78 certifications that I attest to. CIPS is not one of them because we can't -- the guidance is not clear enough that I can with certainty tell you absolutely I can map this.

Now I think I have all the things implemented. I have guidance and documentation that we published to help and we're in the middle of a pilot with an existing customer on how to potentially do that, but I can't guarantee I can't put my money on the line and say yes, I guarantee you will pass the CIP's audit because the guidance is not clear enough from the perspective of these evolving and emerging technologies.

COMMISSIONER LAFLEUR: So do you think instead of regulating all the things that they do we should -- I mean

this was rejected a while ago, but sort of say, just don't have any cybersecurity incidents or you'll pay a big fine, that's to performance? Or will they figure out -- I'll go hire Matt and Ben and do that? I mean if there's been push back on that paradigm.

MR. RATHBUN: So there -- yeah, I think that -- I think effectively they're going to have that problem anyway right, so Microsoft we think about. You don't need to find me if I have a cybersecurity incident, right? My stock price is going to drop many billions of dollars if I do and it's my fault right?

We have plenty of financial incentive from that perspective. I think what's valuable to understand -- and sort of two themes that we've kind of got into in this overall conversation is that these businesses have a need to protect themselves. They're not going to not want to do it, the question is do they have the capability and are we clearly sharing -- are we enabling them to take advantage of existing capabilities and are we clearly sharing that data?

Alright, so I think transparency around how to do this is really what's most important and whether or not it comes down to sharing data with the ISF, is it information around the question we have about should it be a public or private sort of organization -- I think it should be a combination of all of these right?

We want as much data and intelligence as we can get because when it comes right down to it, we all need to look at ourselves in the mirror and admit that the adversaries have more motivation, more funding, more resources than any of us right?

And we need to bind together and be very transparent and open about what we're seeing, how we're acting, how we're solving problems and be as willing as they are to adopt to modern technology and to be flexible and to move if we're going to combat that, because otherwise we're fighting with both arms behind our back.

COMMISSIONER LAFLEUR: I was going to stay on that note but maybe Bill will save me or not.

MR. LAWRENCE: Well Commissioner first I'd like to add one more anniversary to your calendar. It's the 20th anniversary of the ISAC structure so PDD 63 in May of 1998 started the concept and that public private partnership really is exemplified by what we're able to do with the government approved clearances that we get and then the industry trust that we're able to build.

Because as you know the code of conduct prohibits voluntarily shared information to the ISAC to be shared with anybody with compliance monitoring enforcement functions. So in terms of the CIP standards, when we talked to international partners especially -- and I say that outside

the family of North America, they say that it's the best thing out there and they're looking at ways to apply that.

We've grown up differently than a lot of different other sectors, and you know, the discussions on natural gas have applicability in this aspect as well. To see industry wholeheartedly give up on the CIP standards that they have -- they have the capability to develop and influence.

I don't see that kind of same industry input translating into those other regimes.

COMMISSIONER LAFLEUR: Are you sure they're not going to go away, it's just a question of how we learn from all these other elements in making them better. Because I mean I used to go to the whatever it was called -- all the federal, when I was Chairman, all the federal agencies heads and you'd be there with the drug people and the financial people and the nuclear people and they were all jealous of the standards, you know, so everything's relative I guess.

MR. LAWRENCE: And there is an argument to be made about tying somebody's market value in the stock market to their portfolio or image but having something that actually you know, creates those standards as a best practice and a benchmark for security, they have evolved but they're becoming more risk based and that's the high, mediums and the low and that five wall that Ben described is

actually old terminology too.

So as they become more focused and as we're going through the standards effectiveness sub-process that's undergoing too, I think we're going to find ways to make them less burdensome but also to increase information sharing that's going to be more valuable to fight those threats that are out there.

COMMISSIONER LAFLEUR: Thank you for a great discussion. I'll shut up while I still can.

COMMISSIONER GLICK: Thank you, Dr. Hawk, you know I'm not sure if I heard you right but I was struck by earlier you sounded a very optimistic note about our ability through technology to be able to prevent or prevent successful attacks against the grid.

And that's somewhat contrary to if you read all these stories in the newspaper and I know they're stories and some of them are more accurate than others, I'm sure. But about the allegations or assertions that the Russians and others are actually -- have actually successfully gotten into our systems, they just haven't for whatever reason, haven't pulled the trigger so to speak in terms of successfully bringing down -- disrupting power operations for instance.

But I am wondering, it is obviously very difficult and the sub-standards they're always going to lag

behind in some ways because as you point out that's the way government works and it's also the way technology probably works because the technology moves very quickly.

And I'm wondering if we're spending -- and kind of a question for all of you. I wonder if we're spending enough time thinking about restoration and recovery. So to the extent we believe our adversaries do have the capability and maybe one day might pull that trigger -- are we spending enough time thinking about how to restore our system?

I know that there's been a lot of -- you mentioned Ukraine earlier, I know there's some analysis and they're systems are a lot more simple I think and maybe it's easier for them to -- it was easier for them to get to restore service more quickly.

But do you think we spend enough time thinking about that and focusing our resources on that issue?

MS. HAWK: Commissioner, thank you very much for bringing up the real important point. As you say the threat is real, it's series. The adversary is highly sophisticated, becoming more so every day and very targeted, okay, so all of that is true.

It is also true that we have a strong community of folks dedicated to insuring that our energy sector can survive a cyberattack. We're coming at it through a comprehensive approach. We're looking at preparedness, we

are supportive of the private sector to build capacity to prepare for an incident, to respond to an incident and then helping them with the business case by cost sharing the development of technologies that would allow them to survive.

So it's all -- all of the above, right? And in terms of recovery, restoration -- one of the considerations that makes a cyberattack different from a hurricane or a national disaster is that now you may be trying to restore equipment that is no longer trustworthy.

And so we have research going on that is helping us distinguish what is a cyber incident from what may be a failure from a different cause in which where an intelligent adversary can be a difficult determination right?

So we have research going on that address how do you restore a system that may still not be trustworthy -- sort of different.

MR. LAWRENCE: And Commissioner, thanks for that question. We postulate this very severe cyber and physical attack on the grid, taking it -- breaking the grid and then requiring a restoration in certain parts, every two years in Grid X. So Grid X 5 is coming up in November of 2019.

Before Grid X 2, we were already postulating a metcastile attack and once it actually happened in 2013, not only did we have that in the scenario we added the extra

sauce of making an active shooter event so that really added to that.

Postulated on modular malware and then we actually saw it out in the wild. So we've got a team of good guys that thinks of some really evil means to take down the grid and then we put our industry -- and we had over 6500 registered individuals participate last year in Grid X 4 and we're expecting even more next time.

So we're not -- we're doing things in a simulated way. We're also doing things in a real way to get technology out there to our members.

COMMISSIONER GLICK: Does anyone else want to comment?

MR. CRIST: Yeah I guess that's one of the things, you know, from the industry perspective even with the ESCC, with our cyber mutual systems program that's recently been stood up. You know there are a lot of members that were trying to pull on each other's resources if we do have a type of event because as you know trying to bring them back up is going to take a lot of skillsets.

And by having these already predefined agreements in place we can bring those people in quickly. If they know our systems are similar, you know, if they've worked on -- that way we can pull together and kind of do like we do when there are hurricanes in Florida and stuff like that with the

line workers going down there as well.

One thing I would like to say to you, you know, anything about the cybersecurity incident or something that goes down, one thing that we've been looking at too is that EMP threat. We -- when you look at some of the maps and some of the diagrams, Nebraska sits about ground zero if it's centrally located -- if there is some kind of high altitude event there.

So we're looking at containerizing or putting some kind of protection around an off-line scatus system that we could do -- run in a minimal fashion. So it would be kind of you know, last ditch effort but we could pull it out and get up and going on some kind of a system.

So you know, with the work with the ESCC and some of the other, you know, stuff that the CEO for our company's been working on that's a priority for them or you know, something we need to look at.

But then I always struggle with if we put this stuff inside of another container outside of our ESP and PSP now what are my implications for NERC CIP? Am I going to have an auditor come in and say, "Oh, you've got something outside of there now how are you protecting that?"

So we're trying to balance the risk of having a compliance violation with trying to have that incident or response capabilities that we think would serve us well if

there was an event. So again, those are the challenges we get, you know, faced with and it's like okay, how do you balance those out?

We don't want to put the container inside the PSP because it doesn't do much good if you're right next to the other piece of equipment. So that's one of the things, but -- so there's a lot of work going on with that as far as recovery and like Bill mentioned the Grid X exercises really brings a lot of stuff to light too, so there is work being done in that area.

COMMISSIONER GLICK: Mr. Lawrence, different question -- but we discussed earlier I think on the first panel today the need to or the concern or the desire by some of the smaller less well-financed utilities to be able to gain access to EI SAC information and also just you know, the general notion I think this is also true for the Department of Energy perspective of just trying to make sure that they have the sufficient resources to insure that they are also well protected against the cyberattacks.

I was curious -- first of all Mr. Lawrence if you could describe what information you're able and willing to share with them if they're not able to afford it.

MR. LAWRENCE: Thank you Commissioner. So it wasn't specifically discussed in the earlier panel but probably the program that they're talking about not being

able to afford to participate in is CRISP. That had initial costs involved and the initial membership has grown immensely and we kept the costs stable.

So right now individual companies participating in CRISP pay about $200,000 per year for ongoing maintenance and support. And the benefits of those programs actually not only go to the individual organization if they find something, but also to the entire CRISP community and then we get the indicators that compromise that go across all of our members, even if they aren't participating financially in CRISP.

But, as you said, they want ways to have actual, more automated ways to share information with us and to allow us to do analysis of potential intrusions on the IT or OT sides. We are partnering and piloting several initiatives this year to include technology that's very affordable based on how it's deployed and it will give us coverage of both IT and OT networks.

And then also the Department of Energy is helping us expanding the CRISP program to some of the mean using co-ops that will give us the visibility into that aspect of our member portfolio.

Because right now CRISP covers well over 75% of the meters in the United States and with this additional visibility we have a very good sample set of what's going in

and out of the IT networks via CRISP.

COMMISSIONER GLICK: You have a good sample set and this may not be that all the utilities have sufficient information, now maybe some of those less well-financed utilities don't necessarily have as critical equipment in some cases maybe, but still I think it's something that they need -- something I think that that issue needs to be resolved and I know, Dr. Hawk, I don't know if you want to talk about it, I know the Department has several programs aimed at that effort.

MS. HAWK: That's true, you know we partner with the private sector including trade organizations, APPA and RECA, EEI, HAA Inga, we work together with them to ensure that the whole community can benefit from the work that we're doing to build capacity within the sector from those that are less well-resourced to those that are more well-resourced.

And the community comes together and just raises all the votes at the same time, that's our objective.

COMMISSIONER GLICK: You mentioned Inga, and maybe that's probably a good segue to switch the conversation slightly. We've had some discussion today about natural gas cybersecurity. I know this panel is mostly on electric cybersecurity but I'm curious if you have, you know, it was mentioned earlier that Commissioner

Chatterjee and I had joined drafted an op-ed that was in the Houston Chronicle that focused on both whether -- the question of whether gas pipeline sales should be subject to mandatory standards as does electric utilities are.

And also, whether the TSA is the appropriate agency to oversee gas pipeline cybersecurity -- I was curious if you had any thoughts on either of those questions?

MS. HAWK: So the thoughts are that we work with energy at large so we work with the power grid as well as oil and natural gas and again building capacity as well as developing R&D.

For the ONG folks an example of research that we've done in the past for distributed control system is to help them develop a role-based access control that was designed specifically for how the ONG folks operate their systems.

So those roles would be determined based on are you in normal mode, are you in emergency mode, are you starting up, shutting down -- very specific to that environment. So we work with them as well as the power grid folks.

COMMISSONER GLICK: Do you think mandatory standards would be helpful for the gas industry?

MS. HAWK: I think that that would be a decision

that the community would need to make.

COMMISSONER GLICK: Okay, that's a good answer. I was wondering Mr. Sritapan, I hope I pronounced that right -- and I know that that's not, the Homeland Security Department covers a wide variety of TSA, it probably isn't within your ability but the TSA does have authority over natural gas pipelines and TSA decided not to impose mandatory standards. Are you able to comment on that?

MR. SRITAPAN: Unfortunately I'm not, I'm sorry.

COMMISSIONER GLICK: Does anyone else have any opinions on gas pipelines and cybersecurity?

MR. LAWRENCE: We do use experts from the downstream natural gas as mentioned by my CEO that have access to our watch floor. We share very regularly threat information as well as consult each other on outages and then also the Grid X scenario is built with more than just the electricity subsector in mind -- it's truly cross sector.

And also, credentials, getting us on the watch floor of the NK and into DHS for the more cross sector nature really helps stamp out fires in case I think it was last year when there was a subway outage in New York and something else in Los Angeles, and a substation fire in San Francisco and Twitter was blowing up it's a cyberattack.

And we were quickly able to determine it was not

and get that information to our asset owners and operators so that they know the ground truth.

COMMISSIONER GLICK: Mr. Miller, I think your written statement talked about that the concern of some of the CIP standards or CIP requirements sometimes work against actually those trying to defend the grid and rally to the benefit of the attackers.

What can we do -- what, how can we modify those things to make sure that they're effective against the attackers and not deter and inhibit the ability of the defender so to speak?

MR. MILLER: Yeah, so the background there and the concept is that you have attackers you have defenders, right. Now we've -- during this panel kind of put that attacker on the pedestal. We've said they're very good at what they do, they're very sophisticated, watch out but they also in a lot of cases have meetings that they have to go do, they have appointments, they have deadlines, they're humans too.

So that's something to remember. But the concept that if we're constraining our defenders from regulatory or other pressures, whatever they may be, in the attacker has more freedom of movement than the defender, then it's really putting the defender in a poor spot.

So the concept of paralysis during an incident

where you're not prepared so you have to bring in third party support. They have to go through background checks, they have to go through other processes and I think there's been some language around that to help make that a little bit easier, however, there's also the technical aspects of deploying forensics technology inside of an ESPN and touching logs that you may -- they have never even known they existed and then interpreting them and working through that with the software -- those are some of the challenges that we are at now.

I don't think they're necessarily insurmountable. My concern with regulatory potential around the instant response aspect is that it adds more structure which reduces the creativity and the flexibility of the defenders at the -- during the time when they need it the most.

MS. SCIARRONE: Can I just add on to it about the defenders, you know, I think around this area you also see the need for really specific and nuanced knowledge right? And to put that knowledge within your SAC, so just because a lot of these SCATA systems or other types of remote devices are wrapped in TCIP or UDP protocols -- cyber protocols, it doesn't mean that a traditional cybersecurity person is going to understand the nuances of how they're utilized and how to protect them.

And so that knowledge is valuable within a SOC, likewise some of the traditional cybersecurity information is helpful and its' how do you make sure that the defenders have those different pieces and are communicating back and forth?

I mean I still laugh at a really basic example which is basic cybersecurity -- its disable macros. You teach everyone don't enable macros. And the practical nature of understanding and reporting back on the safety of some of the supply chain, you require macros to get that information back to you, right?

And so this is an industry where macros are used and as a basic cyber person I'd be like why would you use those? Why are even enabling macros, just disable them and that's not practical right. And so it's making sure that knowledge is there with the defenders and that SOC builds that all out in making sure that you think of it holistically.

And so I agree with Ben, we have spent a lot of time talking about the attackers and putting them on a pedestal, but I think just as important is to understand what each of these companies are doing on a daily basis from a different standpoint and you have a lot of people working very hard to protect them -- it's how we give them the right information and the right knowledge to do that.

MR. LAWRENCE: Commissioner I would like to touch on something that Paul brought up a little while ago. So the cyber mutual systems program was determined or the need for it was determined with Grid X 3 back in 2015 at the executive tabletop and since between Grid X 3 and 4, industry stood that up, exercised it and then used its capabilities to share industry knowledge pre NDA, pre-cleared people to do some of that cyber assistance and it's I think close to 150 different utilities now -- U.S. and Canada.

I'm racing to the airport after this to go to one of their meetings, so it's a great capability that was grown up with industry, without the need for standards. Then also the ISAC we're building user communities on our portal to give more opportunities for bringing the entire team together because to my colleague's point on the panel, the adversary may be better than one of us, but they're not better than all of us together.

COMMISSIONER GLICK: I was going to ask a last question about what you've learned from the Grid X exercises but I think at least you touched on that. I don't know if there's anything more that you --

MR. LAWRENCE: I think we provided you the reports from Grid X which have a great deal of information there. I'm really looking forward to Grid X 5. Our folks are

making up a really awesome scenario that's going to put our folks through the paces.

And I'd also like to highlight we treat all blackouts like black start opportunities. So Grid X pushes us to the limits without actually going to those drills which we do every year. So even if it was a cyber incident we'd just execute those black star capabilities.

And even though the Ukraine systems aren't as automated as ours, we still do maintain an industry manual capability to switch breakers and get power back on fairly rapidly, even if it was a cyber incident.

COMMISSIONER CHATTERJEE: Do you have anything else?

COMMISSIONER GLICK: No.

COMMISSIONER CHATTERJEE: I want to be sensitive to the flight you're trying to catch but we start a couple minutes late and so by my clock we do have a handful of minutes remaining and I just wanted to see if staff had any questions that they wanted to ask?

MR. MCCLELLAND: Sorry, so I guess I'll just zero in on the vendors in the interest of time. So just very quickly, something that you said Ben, and I'm going to ask Matt, Ben and Neill to all comment on various aspects -- so Matt, based on the information you're collecting, I'm betting it's a Microsoft system, so how does that relate or

how can that correspond to the OT systems.

And then Ben a question for you is on recovery, it's something Commissioner Glick talked about restoration and recovery. Have you seen -- and you talked about the flyaway team so you're in the recovery business I assume, have you seen lessons learned and sort of preparations that we can use industry-wide that we might be able to share with say Bill, over at the ISAC to get people to say rack and stack equipment?

And then Neill for you, is there -- and I'm betting there's not, but are there silver bullet technologies that we should be more interested in than not. So if you could just maybe move rapid fire in case my colleague David has some questions.

MR. RATHBUN: Sure, very quickly. We look beyond just Microsoft technology so we're getting telemetry back from Microsoft installed devices but we're looking for the fingerprints of adversaries no matter what system they're attacking.

We then take that, reverse engineer that -- that's how we inform other organizations that we've identified problems in their own code because we're seeing active exploits in the wild.

MR. MILLER: So I -- yes there's been a lot of changes, even with TRISC, which impacted triconic safety

controller. The challenge there was that was the first time we had seen a memory resonant root kit on side of the controller, so that changes the game.

Before that we were focused on the control protocols of issuing commands that happen to be on the same network. This is something different where it's persistent on that device and it's in a very stealthy fashion.

Approaching that from a forensic perspective and understanding and pulling that part -- that is the bleeding edge of where we are in this game that we're playing.

MS. SCIARRONE: I would say anyone who tells you they have a silver bullet run because they're lying. I think it's all about there's some new technologies and new folks and you know making sure you're looking holistically, focusing not only internal in what you're doing internal to your network, but also external and what are those external factors with the adversary.

MR. ORTIZ: I have a question primarily for Carol. You mentioned that a lot of your work is engaging with vendors trying to in the community to develop new technologies and to test those. How is it that you work with the vendors to insure that as that technology gets from the research to the kind of limitation phase that you're taking care of identifying and addressing potential supply chain vulnerabilities?

MS. HAWK: Thank you for raising that, that's a very important point. And so we partner across the community -- we partner with suppliers, we partner with utilities, so the owners, operators, we partner with universities and we have 10 national labs and we work with trade associations so all of the above.

And the projects we will typically have a red team component so we'll have a third party part of that project -- red team, the resulting technology, to look for any weaknesses that might be introduced.

MR. KUEHNLE: If I could -- I think I'll just throw this out to the entire panel because it's kind of broad. So Ben had mentioned earlier about the people right? And that's one of the things I've seen through my career is you can buy what you think is a silver bullet or throw technology out there but it all comes down to having people being able to configure that and operate it.

And one of the things I've also saw through my career is as you continue to throw new technologies into the environment your people have to learn those new technologies and be able to operate those right?

So maybe one of you can jump in and kind of talk about as this new technology is emerging and being put into the network, how are you dealing with the people aspect of that in making sure that they're keeping pace with that new

technology and securing those networks?

Because a lot of times I also saw that how hackers are able to get in -- the attacker, is because there's a misconfiguration and people really don't understand how that technology is operating.

So how do you keep pace with that technology change with the people, with just making sure that you are secure?

MS. HAWK: Thanks Barry. So the way that we get cybersecurity measures deployed and we've gone nationwide now. So SEDS funded technology can be found in every state in the nation reducing the cyber risk to the energy sector.

The way that we do that is to ensure that what we produce, first and foremost does no harm, works well within that operational environment and in the best cases reduces the operations and maintenance and that's why we've been able to go nationwide and that is why we use partnerships because you have the folks on the receiving end of that technology engaged in the research deep and early, right at the beginning so they can give that guidance to insure that it is something that can be easily used.

We're advancing technology that simplifies the system while making it more cyber secure. So SDN which I brought up earlier has offered to fund networking specifically tailored to the OT environment is one example

of that.

Establishing a deny by default operational network that it simplifies the system, it gives visibility that was difficult, you know, without that, global visibility across the network and it allows the possibility of automating a response anticipating a cyberattack and then pre-engineering traffic flow to adapt to survive that cyberattack.

So simplification is very important to the point that you raised and it's very important to what we do, making sure that we're reducing the operations and maintenance while we are reducing cyber risk.

MR. PARKINSON: Yeah I had one question. It goes to some dialogue we had earlier about security risk versus compliance risk and I may have misheard this but I thought that in one of the exchanges -- and I think it was you Paul, said that if there's a compliance risk and there's a real live security risk that would be a difficult call in which you addressed for us in terms of mitigation.

And I found that troubling and I'm the guy who wears an enforcement hat and I guess I haven't -- I guess I have the impression that we shouldn't be that scary in the context of a real security risk you would have to hesitate and maybe even choose mitigating a compliance risk under the CIP standards as opposed to addressing the security risk and

then explaining when one of my auditors or somebody else shows up, one of David's folks shows up and says, we'll what happened here.

That the regulator wouldn't be sympathetic to that -- particularly, and I've also seen the context of CIP violations and CIP penalties and the anonymous nature of it and so I guess the long winded way of saying and Bill could address this too, is the danger of being out of compliance with one of the CIP standards that's significant, that that's a hard call.

MR. CRIST: Well I guess the incident there or what was brought up was there was a threat that was identified. It was you know, with the software that was out there that was being used for anti-virus or for malware protection.

Well when you look at what is that threat if you don't have all that information is it is a threat that's immediate or imminent, you know, I think it would be the utility would lean towards take it out right away, get rid of it, we'll worry about compliance later.

But when you have a security risk that's like you know, a major broadcast saying this could be bad software but we don't know yet -- now the utility might have to remove that and now they've got to figure out what's our other option here.

You know there are other mitigating measures, we don't have those so we've got to figure out, you know, what we do here to meet compliance when we remove this from our CIP compliance program.

So you know if the threat's not imminent they're probably going to take the risk there of saying, okay, you know, I don't have enough information to say hey, we'll suffer the financial penalty if we get one through a compliance audit or we'll leave this software in.

I mean that's kind of a challenge there. I think you're right, if there was an imminent threat and we knew, like something came out for you know, a major NERC alert saying get this stuff out of your network, I think we would -- everybody would get it out of there you know and then figure out a way to get through the compliance piece of it.

I will say you know, in the MRO region we have a pretty good relationship with the auditors and we can ask questions like that and I think a lot of regions have that as well. I think we get to that point and I know this issue -- I did bring it up to some of the FERC staff too and I was trying to work through some of that saying okay, here's an option or here's something that industry has brought to me through some of the other work that I do with the CIP how do you handle this?

You know, these are the challenges we have. I

would, you know my concern -- my own personal concern being you know, from a protective relay world and checking out sub-stations and control networks in generation plants, patch management just emailed this 45 day notice to put your patches in just after I spent months putting this system in in a controlled network, knowing -- putting my stamp of approval on it and 45 days later a security release or patch release comes out and now you're going to go on there and change something.

You know, that's my challenge that I have too is supply chain when you talk about threats from there, I just went and put something else introduced something after I tested out this control operational network to guarantee that it would work when it needed to and now you've changed some of those variables that I've already went through all this testing on.

So you know, that's another one that I guess I'd want to highlight too is you know, that's a challenge you have if you have a security release or something comes out, when can I apply that -- do I do it while the system's hot? Do I do it as soon as I -- do I take the system out of service to put this in and then you've got to work through all of that.

So I know that's another challenge with the industry too when you balance those security aspects versus

compliance.

MR. KUEHNLE: Actually, Paul this question is actually for you. So you had brought up cloud before and you had talked about the fact of moving operational technologies into the cloud and some of the problem that you may have with that because of the fact that they're operational technologies being used in that environment.

So would you see that -- maybe as a hybrid of using the cloud where you only put ancillary services that communicate with operational devices? Can you maybe talk a little bit about that?

MR. CRIST: Yeah, I guess with the approach that we're taking right now with the cloud is just even the best cyber system information. So when you're talking about some of the you know, applications that maybe are stored on a server or stuff like that, where do we store that information because we have to lock those containers down too and can't share that.

The operational side -- maybe even the monitoring piece, you know that's where -- as a smaller utility and even smaller utilities, public power, NRE, you know, the co-ops, you know you can't have a 24 by 7 SOC or you know the budget would be outrageous.

But to be able to even share that information or the logs and maybe even some of the stuff Ben was talking

about is having some people with that skillset and leveraging that to review those logs and provide us back with that information.

So on that cloud side yeah, it's the ECUMS if you're familiar with those or the monitoring systems, the logs, you know, where can we get that valuable information and take real time action on it?

The operational piece like a SCATA system or a control network, personally I maybe struggle with that but there are people in the industry that are moving towards that and I know there's people that are out there with that kind of stuff at a lower level.

So it's probably going to work there. Where does it end -- I don't know but you know, there's again -- if I could put my SCATA back-up system somewhere on the east coast or west coast and then the EMP happens I at least have some way of operating that maybe that will provide some resiliency in those type of events if I can make sure it's secure.

I probably wouldn't be I guess at this point operating it. Maybe that's a little longer down the road but there are utilities that are doing that so it is -- now it becomes even a more bigger struggle. Like I said I think industry will move into that and try to get there and some have but we've got to make sure the NERC's sub-standards

allow that and we don't run into issues there.

And whether it's the auditors or the standards themselves that need to address that, that's what we've got to figure out.

MR. MILLER: If I can just add on to that. So I think the whipping boy for new technology in the discussion has been like out of cloud and virtualization which makes sense because it is a paradigm shift and we have to wrap our head around that.

The last panel was very interesting talking about -- I think it was Nicholas Miller mentioned all the various knobs accessible for the inverter and those aren't electro-mechanical knobs that he was referring to, that was driven by software.

So there's a move to intelligence to the edge as well and that is as much of a paradigm shift as like a cloud and virtualization, it's just -- I think it's a more approachable topic for the sector and power systems to understand. So they're both challenging and they both need to be addressed.

COMMISSIONER CHATTERJEE: Seeing no further questions I think from myself and the Chairman I just wanted to say thank you to all of our panelists, to the Chairman's team and to the senior staff for helping to put together the materials and for the staff it was so helpful in organizing

and putting this together.

I thought it was a very, very successful day and I thank you and turn it over to my colleague.

COMMISSIONER LAFLEUR: Certainly just to second the thanks to all the panelists for a very engaging discussion -- all four panels and to all the folks here at FERC, Lodi who had her name on the notice, that's always a hazardous place to be and everyone else who worked on this and for everything that the people in OER and OI's do all year long with NERC and others in this area, thank you.

COMMISSIONER GLICK: Obviously thank you all for participating, it was very interesting. The whole day, I really learned a lot from the entire day but also I especially want to thank the staff and everyone for putting everything together. A binder with 63 different tabs is quite a bit of reading but it was very helpful so thank you.

COMMISSIONER CHATTERJEE: Thank you everyone.

(Whereupon at 5:00 p.m., the technical conference was adjouned.)

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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: 2018 Reliabiltity Technical Conference Regarding the Bulk-Powe System

Docket No.: AD18-11-000

Place: Washington, D.C.

Date: Tuesday, July 31, 2018

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.

Lary Flowers

Official Reporter