UNITED STATES OF AMERICA

FEDERAL ENERGY REGULATORY COMMISSION

Technical Conference
to Discuss Climate Change,
Extreme Weather, & Electric
System Reliability   Docket No: AD21-13-000

TECHNICAL CONFERENCE

Via WebEx

Federal Energy Regulatory Commission

888 1st Street NE

Washington, DC 20426

Tuesday, June 1, 2021

1:00 p.m.

Welcome and Opening Remarks

Introductory Presentation - More Frequent and Expensive Extreme Weather Events
Adam Smith, Applied Climatologist, National Oceanic and Atmospheric Administration

Panel 1: Planning for a Future that Diverges from Historical Trends.
Romany Webb, Associate Research Scholar/Senior Fellow at the Sabin Center for Climate Change Law, Columbia University Law School
Derek Stenclik, President, Telos Energy, Inc.
Susanne DesRoches, Deputy Director of Infrastructure and Energy, New York City Mayor's Offices of Resiliency and Sustainability.
Lisa Barton, Executive Vice President/Chief Operating Officer, American Electric Power
Judy Chang, Undersecretary of Energy, Massachusetts
Jessica Hogle, Federal Affairs/Chief Sustainability Officer, Pacific Gas and Electric Corporation
David Easterling, Ph.D., Director, National Climate Assessment Technical Support Unit NOAA's National Centers for Environmental Information.

Panel 2: Best Practices for Long-Term Planning Assessing and Mitigating the Risk of Climate Change and Extreme Weather Events

Judith Curry, President, Climate Forecast Applications Network

Neal Millar, Vice President Transmission Planning and Infrastructure Development at the California ISO

Mark Lauby, Senior Vice President/Chief Engineer, NERC

Devin Hartman, Director of Energy and Environmental Police, R Street Institute

Alison Silverstein, Independent Consultant, Alison Silverstein Consulting

Richard Tabors, President. Tabors Caramanis Rudkevich

Frederick Heinle, Assistant People's Counsel, Office of the People's Counsel for the District of Columbia.

P R O C E E D I N G S

(1:00 p.m.)

MR. AMERKHAIL: Welcome my name is Rahim Amerkhail, and I'm from the Commission's Office of Energy Policy and Innovation. We are happy to welcome you to this technical conference to discuss climate change, extreme weather and electric system reliability.,

Before we begin with opening remarks I will outline some logistics for the conference. This conference will take place over two afternoons from approximately 1:00 p.m. to 6:00 p.m. eastern time each day. We will have an opening presentation and two panels today, followed by three panels tomorrow afternoon.

We will also have breaks in between the panels. Only the Commissioners, panelists and a small group of Commission staff will have the ability to speak today. This conference is being webcast and transcribed, and I believe the webcast will be archived for those who need to watch it later.

The purpose of this conference is to discuss issues surrounding the threat to electric system reliability posed by climate change and extreme weather events. We do not intend to discuss specific details of any pending, contested proceedings before the Commission whether they're listed on the supplemental notice issued on May 27th or not.

And we ask that all participants similarly refrain from such discussion. If anyone engages in these kinds of discussions, my colleague Michael Haddad from the Office of General Counsel will interrupt the discussion to ask the speaker to avoid that topic. With those initial matters out of the way I will now turn it over to Chairman Glick for his opening remarks. Mr. Chairman?

Welcome and Opening Remarks

CHAIRMAN GLICK: Thank you very much Rahim can you hear me?

MR. AMERKHAIL: Yes.

CHAIRMAN GLICK: Great, great, I appreciate it. So thank you and also thanks to the team for putting together this technical conference for the next two days. I think it's going to be very interesting. I also want to thank the panelists for being willing to participate in the conference over the next two days and for taking the time to do so. We really appreciate your participation, it's very helpful to us.

You know I think if you look at the last couple summer and winter reliability assessments that the Commission staff puts out on occasion. I think all you have to do is look at those and all you have to do is read those, and you will all understand how important weather is -- extreme weather is to grid reliability.

Certainly, it's something that we pay a lot of attention to, but I think the courts suggest that it has always been important, but even more important as of late. Climate change is a real phenomenon and I think the extreme weather that we see around the country, whether it be drought and wildfires in the west, extreme instances of heat or extreme cold waves that occur, floods, hurricanes, more ferocious hurricanes than we've seen before and greater numbers as well.

There's clearly something going on, and I think most scientists would suggest that certainly climate change. But from our perspective we need to figure out what that all means for the grid. And I think you know we used to have in most cases people would assume that you would have the 100 year flood, or the 100 year this or that, and all these events are now taking place once ever few years, it's no longer once every 100 years.

And I think we need to figure out on a going forward basis what that means again for the grid reliability and act accordingly. And you know as I think as we saw in Texas most recently, but we've seen it elsewhere before, grid reliability and access to electricity is not just the incident of convenience that when the lights go out you know we're inconvenienced for a couple hours.

Sometimes it's a loss worse than that as we saw in Texas most recently. It literally is a matter of life and death on some occasions, so we have a duty, a solemn duty to try to ensure reasonable power system, ensure reliability, and take a look at these instances and try to figure out what's to do next. And I think that the next two days -- this afternoon and then tomorrow afternoon the discussion that is going to take place is very important from FERC's perspective.

We need to figure out from our perspective is there anything to do from reliability rules for the ways in which we regulate jurisdictional utilities. How do we better address the fact that utilities need to plan for these extreme weather conditions on a more frequent basis and how to play for them both in the planning perspective, but also an operational perspective.

And I'm looking forward to the discussion today and tomorrow because I think that's going to be extremely helpful. I will be, and I plan to listen to almost all of it. I think I might have a conflict later tomorrow afternoon, but other than that I'll most certainly be listening and participating, and again look forward to what I think is going to be a very helpful discussion over the next couple days, so thanks very much Rahim.

MR. AMERKHAIL: Thank you Mr. Chairman. I believe Commissioners Clements and Christie also want to say a few words. Let's start with Commissioner Clements please.

COMMISSIONER CLEMENTS: Thank you Rahim and thank you Chairman Glick. Appreciate Rahim, especially all the work you've done, along with the team to get this important technical conference up and going.

The Chairman just spoke to the kinds of threats and the seriousness of the changing threat that climate change is imposing in terms of increasing extreme weather. So to combat these threats we need to move beyond traditional, you know, best practice for planning from the past, and deliberately think about and plan for these bigger challenges. And we just do so recognizing that we're going through an energy transition and a mix of resources that grid operator will call upon to meet these challenges. It's changing.

You know that economics, public policy, and customer preferences are causing a proliferation of wind and solar resources, and now more recently energy storage technologies and offshore wind have begun to gain a market foothold, and are certainly poised for significant future growth.

It's important for me to remember that our job is not to halt progress towards a cheaper, more flexible and more resilient electricity system, but to protect customers and ensure reliability along the way. Success requires smart planning operations and reliability regimes that embrace this reality of extreme weather risk.

Certainly states and utilities and regions have started to make progress already on this front. Today is the first time that the Commission has devoted a technical conference to examining specifically how the system must respond to climate change. So I'm looking forward to hearing from all of you on these issues of planning operations, recovery and restoration practices, and how they can be improved to better address this threat.

And I commend you Chairman Glick, and the team for putting this together. We appreciate all the work. That's it for me.

Introductory Presentation - More Frequent and Expensive Extreme Weather Events

MR. AMERKHAIL: Thank you Commissioner Clements. Commissioner Christie are you on? I don't see Commissioner Christie on the Webex yet, so perhaps we'll have a chance to hear from him later. So at this point thank you Mr. Chairman and Commissioners.

I will now hand it over to Adam Smith, an applied climatologist from the National Oceanic and Atmospheric Administration who will help us set the state with respect to the kinds of change and extreme weather problems our panels will be discussing for the next two afternoons. Mr.

Smith?

MR. SMITH: Thank you. Thank you for having us today, and I think that this will be a very fruitful discussion. I'm waiting for the slides. All right great thank you. All right. So there's a lot to unpack here and I'm going to go to a macro to micro to back to a macro perspective to over how the extremes have affected the United States over the last 41 years.

Try to give a better perspective over the disaster costs, over space and time, looking at some other metrics and charts and tools that you can look at yourself. We try to be very transparent with this information. Next slide please.

So here's a brief outline. First I'd like to offer context for measuring disaster impact, then we'll get into the public and private sector data versus the years, what we're measuring, also what we're not measuring. The third and fourth sections are really the meat of the presentation regarding the 2020 U.S. disaster events that happened across the United States, put those into historical context, and also finish up with different cost comparisons over space and time and looking at different new tools that we have to unpack this data, to get better context. Next slide please.

So NOAA's National Centers for Environmental

Information since 1950 has really been the mission scorekeeper regarding trends and anomalies for various weather and climate events. And we have hundreds of different products and services. One of those is the U.S. Billion Dollar Weather and Climate Disaster project which goes from 1980 to present. It's a quarterly project.

And so a billion dollars for an event is an arbitrary threshold, but it just so happens to be a useful threshold. You can see at the bottom of the slide that the first 20 years of the period of record these billion dollar weather and climate events were about 75 percent of the full cost distribution for all weather and climate related events at all scales and all loss levels.

And you can see how that has increased to in fact a bit more than 85 percent of the full distribution from 1980 through 2020. 1.9 of 2.2 trillion dollars in total direct losses. And certainly, over the last several years the wildfires out west and the hurricanes in the Gulf and the Atlantic states have further skewed this distribution, but we'll get into that further. Next slide please.

So certainly there are several different ways you can measure the disastrous impact. First if you see the left part of the slide it shows many of the different hazards that we focus on -- tornadoes, wildfires, inland floods, droughts, heatwaves, winter storms, hurricanes.

We do not currently work on geophysical events such as earthquakes or volcanic eruptions. Now in the center in the right portion of the slide, the green box is really highlighting where the best public and private sector data for analyzing disasters currently exists. The purple and blue boxes are where the data is more heterogeneous over space and time, and therefore we don't really bring it into this product because of the inconsistency of the data.

So I'll unpack that a bit further in the next few slides. Next slide. And one more please. So it's really to capture all of this data it requires a broad array of public and private sector data sources and partners. The table shows the intersection from the seven different hazards as part of this billion dollar disaster portfolio at the top of the table which intersect with our primary data providers in the left column.

The property claim service is really a gold standard for property insurance in the United States. FEMA's presence with disaster declaration data, the national flood insurance program data, USCA's crop insurance data, also the national interagency fire center, the Energy Information Administration, the U.S. Army Corps of Engineers, and state agencies provide valuable context, ex-post after disasters.

And so you can see there's a lot of variability on the data providers versus the hazards, but I think at the bottom it's really the takeaway. What we're trying to capture are total direct losses. That would be the insured and uninsured losses for a variety of assets you see listed, the damage to residential, commercial buildings, government buildings, the contents of those buildings.

Time element losses such as business interruption, damage to vehicles, boats, offshore energy platforms like in the Gulf of Mexico that are challenged by hurricanes. Also crops, livestock, commercial timber and let's see there we go. But let me also highlight we do not account for things like natural capital losses that are outside of the marketplace.

Also, mental and physical healthcare costs, and also all the downstream supply chain ripple effects outside of a hazard region, we don't capture those either. So suffice to say that this is a conservative but solid estimate for the direct total losses that we can measure, but certainly there are variables that we cannot. Next slide please.

All right one more slide please. So now getting into what happened last year. Of course COVID certainly was unfortunately the story of 2020, but it wasn't for COVID I think we'd be more talking about the extreme weather that happened from coast to coast. The wildfires out west --

California, Oregon, Washington State, Colorado, all had historical wildfire seasons.

Of course the Gulf Coast, you can see a record number of hurricanes. Only 12 tropical cyclones hit the United States which was a record, and 7 of the 12 were actually billion dollar hurricane events, which was also a record. Unfortunately, Louisiana was hit by 5 of those.

But and we also can't forget the very historically strong duration that raped the upper Midwest. That was an 11 billion dollar event impacting the agriculture, utilities and homes, businesses, livelihoods, but the most-costly event of the year was Hurricane Laura, which was a strong category 4 that hit earlier in the Hurricane season. That was a 19 billion dollar event.

So from these 22 events which was a record breaking the previous annual record of 16 events set in 2011 and 2017, so 2020 was really an outlier, but it was the hurricane and the wildfire seasons that I think were the historical takeaways from last year, next slide please.

So this is a pretty loaded chart, and it essentially reflects the aggregate exposure values at risk, vulnerability, where we build, how we build, and of course the effects of climate change on some of these extremes. And you can see each of the last 41 years the bar represents the count of these billion dollar disasters somewhere in the

United States. You can also look at this at a state level as well.

And they're collocated by hazard type which you can see at the top. But what I would also like to highlight is that so 2015 through 2020 was the sixth consecutive year that we've had at least 10 separate billion dollar disaster events, but last year more than doubled that recent standard.

But I think more telling is the costs, so the five year average cost which is the black line, is 120 billion dollars in just total direct losses in the United States which is a record. So over the last five years that's in excess of 600 billion dollars, and from the impacts from these extreme events.

I'd also like to highlight that some of the outlier years, of course you see let's go back one slide please, the 2017 was the most-costly year. 2005 would be the second most-costly, followed by 2012, but last year was the fourth most costly year, and we'll look at that in a little bit more detail. Next slide please.

So here are different ways to look at the data. Now this is a cumulative aggregate of the frequency of these billion dollar disaster events, each of the last 41 years. The black line is again the 41 year inflation adjusted average number of events per year. I should say that all the dollar figures in this plot today are inflationary adjusted to present day dollars.

The red line would again be the outlier for the year 2020, you know, head and shoulders above the other years. But as you can see we've had a number of recent years that have been quite high on the distribution. And this chart right here actually is perhaps more useful. It shows the cost distribution, the previous chart was the frequency, this is the cost distribution.

The 41 year inflation adjusted cost averages 46.5 billion, and the black line again you see the red line is 2020, it was in fourth place just behind 2012, 2005 and of course 2017 when we had Harvey, Irma, and Maria in addition to western wildfires. Those costs were in excessive of 300 billion.

I'd like to highlight two things. One would be the distribution of the gray lines between 10 and 40 billion, and of course the outlier years above it. And the commonality with the outlier years at the top of the distribution are large hurricanes hitting large metropolitan regions -- Harvey, Katrina, Rita, Wilma, Irma, you name it.

So certainly the exposure we have on the coast from hurricanes is the highest cost threat for these weather and climate extremes for this product. Next slide please.

All right one more slide. So here over the last

41 years from January 1980 through March 2020, we've had 291 separate billion dollar weather or climate related events. And so, the cumulative costs you could see at the bottom is 1.9 trillion. So what I have circled here are a few takeaways.

One, it does not surprise people that tropical cyclones, which are of course hurricanes and tropical storms, make up the lion's share of the losses, a little bit more than 1 trillion dollars. This is from 52 hurricane, or strong tropical storm events. And the average cost is 19.4 billion per event.

It does surprise people that drought and heatwaves have a secondarily high cost of 261 billion, so one quarter of one trillion. But I think what's kind of being overshadowed is what's happening with wildfires. You see wildfires is 100.3 billion dollars in total direct losses. It is notable that that has effectively doubled in the last four years due to catastrophic wildfires across the west in 2017, 2018 and 2020.

Unfortunately, this year is looking like another challenging wildfire year. So wildfire costs are increasing proportionately the fastest. Next slide please, back one please, yes. So this is the same data except its partitioned by decade. What I have circled is the 2010 decade and you can see the large jump over the 2000's decade from 63 billion dollar disasters to basically doubled to 123.

And also the cost went from 527 billion to 825 billion. And of course exposure, vulnerability, and climate change are all drivers for these increases in losses with you know regional variations. But I think the takeaway is you know it comes down back to how vulnerable are we and that's you know, a very challenging question to examine.

So these numbers continue to rise for a variety of reasons as I mentioned, so let's look at that a bit further. Next slide please. So this shows that the spatial footprint of these billion dollar disasters really is ubiquitous. No matter where you live in the United States over the last 41 years it shows the billion dollar aggregate footprint of these different hazards.

So the top left drought and heatwave is everywhere. The south, the central, the southeastern, but more recently the west have really had their fair share of drought and heatwave impacts. Winter storms in the top center, you see it's more to the east, and a lot of that is exposure with large population centers in the northeast, and nor'easter events that create hail -- excuse me, snow, ice, wind and storm surge damage, so that's an exposure map right there.

Tropical cyclones really from Texas to New

England, and even well inland as they become extra tropical and rain themselves out, you know the hazard is prominent there. Bottom left flooding -- this would be non-hurricane, non-tropical flooding just from urban flooding or river basin flooding, and you see as the water flows to the tributaries into the main river basins, Texas, Louisiana, Arkansas, the deep south really gets a lot of the flooding impacts.

Bottom center wildfires. Again, mostly a western phenomenon, also Alaska and the southeast have impacts as well, but California, Oregon, other western states are really the most challenged with wildfire. And then severe local storms, also on the bottom right fairly ubiquitous, but mostly east of the Rockies due to geography and the way that weather patterns set up. Next slide please.

So if you take all of those previous maps I just spoke of and put them together, this is a map you have the total aggregate. The total frequency of these events over the last 41 years. And Texas leads the way. But of course Texas has a spatial vice being the largest state, or one of the large population states with a large economy, so it has a lot at risk. Let's go one more slide please.

But this slide is more telling because it's looking at the cumulative cost frequency over the last 41 years. Again, Texas leads the way about 300 billion dollars in total direct losses, and it gets all the hazards that we focus on. Florida would be second at about 240 billion, most of those are hurricane impacts that you would expect.

And finally, in Louisiana it's third at about 220 billion, but it has a much smaller economy and population than either Texas or Florida, so as highest relative impacts to these events. Also, Puerto Rico and the U.S. Virgin Islands are impacted by hurricanes, which we also capture. But really, you can see much of the country, particularly the central and eastern part plus California are really impacted by these events in true dollars and cents. One more slide please.

And we just saw this last year. So 2020, this is a map showing the 2020 disaster costs with respect to each state's economy size, their GSP, or GDP. So you can see Louisiana led the way at about 7.5 to 10 percent of its state's economy, that was the size of the damages from the hurricanes that happened last year. Also Iowa, it pops out from the ratio impacts in many central states from severe conductive storm impacts from tornadoes, hails and straight line thunderstorm wind damage.

But you can look at this tool in a variety of ways. We're just scratching the surface with this presentation, but I think this is a valuable metric we look at. One more slide please. And this is just a snapshot showing that these extremes of course are seasonal.

In the springtime we expect severe storm events, and inland flooding events in the blue and the green there, as opposed to the fall months where it's more tropical cyclone, wildfire and drought events that are causing the most damage as we've seen every year in the last several years. It just plays out almost like a record.

And you can go look at this for your own state. But let's go one more slide please. One of the more I think interesting areas to look at is this concept of cascading or compound hazards, basically when extreme events happen in a small space time window. And so this is looking at the 291 separate billion dollar disaster events for the United States over the last four decades, and how -- what's the statistical frequency for them to happen in the same month in the same geography.

And again you can see how the spring and the fall months pop out with the highest risk for compound frequency, and again Louisiana is a great example. They were hit by five tropical cyclones last year. So the reason that's important is it increases cost recovery time, and it just lengthens, delays the recovery process and increased demand surge for materials and for labor and we see that in these March - June disasters, or these compound disasters.

And finally, I'd like to highlight what was noted in the fourth national climate assessment a few years back, "The physical and socioeconomic impacts of compound extreme events such as simultaneous heat and drought, wildfires associated with hot and dry conditions or flooding associated with hot or high precipitation on top of a water logged ground, the impacts are greater than the sum of its parts."

And finally, here is the website for the maps and the charts and tools I showed you and our core review on climate.gov regarding the billion dollar disasters last year, and my email and some great literature. And with that thank you.

MR. AMERKHAIL: Thank you very much Mr. Smith. That was very helpful and quite sobering as your teams work and your presentation demonstrate the electric industry faces significant weather-related challenges ahead.

Before I turn it over to our moderators for Panel 1, I see that Commissioner Christie has arrived. Commissioner Christie would you like to make any opening remarks?

COMMISSIONER CHRISTIE: Thanks Rahim, and I would just say I've been having technical issues and not fully resolved yet, so I will not say much. But I want to thank all the panelists that put a lot of work into this. And I want to thank all the staff that put a lot of work into this, and with that I will sign off and listen and hopefully get my technical issues resolved before too long, so thank you very much.

Panel 1: Planning for a Future that Diverges from Historical Trends.

MR. AMERKHAIL: Thank you Commissioner. I will now turn it over to our moderators for the first panel entitled, "Planning for a Future that Diverges from Historical Trends," so we can start exploring potential responses to the challenges that Mr. Smith and others have raised. Louise?

MS. NUTTER: Hello. I'm Louise Nutter from the Office of Electric Reliability, and along with my colleague Ena Agbedia, also from the Office of Electric Reliability, I will be moderating this panel.

Our first panel today will explore the ways in which planning inputs and practices, including those used in resource adequacy planning, transmission planning, integrated resource planning, and asset development and management, should evolve to achieve outcomes that reflect consumer needs for reliable electricity in the face of patterns of climate change and extreme weather events that diverges from historical trends.

We will be foregoing opening remarks for this panel, and will move directly into a question and answer session. If a panelist would like to answer a question, please use Webex raise hand function. Alternatively, if you are having any issues with the raise hand function, please turn on your microphone and indicate that you would like to respond.

I will call on panelists that indicate that they would like to answer in turn. At that time please turn your microphone on and respond to the question. When you've completed your answer please turn off the microphone, lower your virtual hand in Webex.

I'd like to start by welcoming our panelists. We have Romany Webb, Associate Research Scholar/Senior Fellow at the Sabin Center for Climate Change Law, Columbia University Law School;

Derek Stenclik, Founding Partner Telos Energy; Susanne DesRoches, Deputy Director of Infrastructure and Energy of the New York City Mayor's Office of Resiliency and Sustainability; Lisa Barton, Executive Vice President, Chief Operating Officer, American Electric Power;

Judy Chang, Undersecretary of Energy with the State of Massachusetts; Jessica Hogle, Federal Affairs/Chief Sustainability Officer at PG&E and Doctor David Easterling, Director of National Climate Assessment Technical Support Unit. And now I will turn it over to my colleague Ena to introduce the first question.

MR. AGBEDIA: Thank you Louise. So panelists, the first question we are going to address today, with respect to typical inputs to planning, such as expected future loads, weather, temperature, et cetera, how can such futures-based inputs be projected more accurately (or usefully) than simply extending historical trends forward?

I'll turn this first question to Mr. Stenclik please.

MR. STENCLIK: Yeah sure, so I can take a first stab at that. One thing I think is critical when you think about evaluating climate change in the electric power sector, you know, the first thing is it's not adequate just to introduce a warming trend, because I think normal warming, or even if it's not normal, that warming trend is not what's going to catch the electric power system off-guard.

Really what the power system is going to be most concerned with is the correlated events that come from that, whether it's multiple days of extreme heat that occur back to back to back, if it's weather events that occur outside of our normal risk periods, I think that's key when we think about electric power system reliability historically across most of North America we've been focused predominantly on hot summer afternoons.

And I think for all the system planners out there, it's going to be really critical to widen that view, and say it's not just that afternoon summer peak that's going to be critical anymore, we need to start looking more at what anomalous weather that might not be as hot or as humid as the summer peak, but occurs in a time period that the power system wasn't necessarily designed to meet the same way it was for the summer peak period.

So I think you know it's not just about introducing that warming trend, because really if you look at the way the resource mix is moving into a lot of solar, a lot of storage, I'm not convinced that summer hot period is going to be the peak risk anymore. It's going to be winter periods, or shoulder periods where it's anomalous weather around what the power system wasn't designed for historically.

So I think when we think about climate data, and how we introduce that in the power system planning, it's not necessarily the warming trend we have to worry about, it's these anomalous weather events. It's a multi-day low wind and solar event. It's the extreme cold and how that has ramifications on the gas supply and mechanical failures.

So it's really the correlated events that we have to worry about where it can lead to cascading values across the network as well as chronological hour to hour changes in the way the power system operates.

MS. NUTTER: Thank you. I think that got us off to a great start. Is there anyone else? Oh, I see two people, three people. Jessica Hogle I saw yours first, would you like to go first please?

MS. HOGLE: Sure thanks Louise. I just want to build on those last comments. I think you know we know that the impacts of climate change are going to be both kind of acute and chronic over the long-term. So a first step for us at PG&E was really just back in 2015 identifying what are the universal climate driven impacts that we think we are going to experience. And there were six, including drought, wildfires, sea level rise, land subsidence, more heavy and increased storms et cetera.

And then you know the next phase, and we worked on you know with our CPUC and other stakeholders, a process to identify what a good current vulnerability assessment looks like, how do we incorporate and understand that data? And in that process what we're looking at okay, what is the exposure that exists, which I just discussed.

What is the sensitivity of our assets in the exposure of those assets to those climate-driven risks, and then finally what is the adaptive capacity of our infrastructure to those risks? And by adaptive capacity that means you know how easy would it be, what are the resources available, or knowledge available that we have to be able to respond to these?

So a good way to think about that is a transformer that's sensitive to heat relatively higher adaptive capacity because we can change that transformer relatively easily. However, a you know, a substation that is subject to sea level rise, that you know, is less adaptive capacity because we would either have to relocate it or rise it. It would take more to be able to do that.

And so you know I think how you -- what are the best practices and how you use that data is you know understanding what your risks are, how that impacts your assets, and then how easy it would be to address those risks. And then obviously, when you understand kind of the window of time, some risks that you're going to experience today, and that we're already experiencing today in California, like drought, wildfires, and heatwaves.

You know those require kind of nearer term actions, and then you have over at the long-term more ability to address the sea level rise, things that are over, you know, chronic over the long-term. So I think it's gathering the data and then incorporating and leveraging that data to inform your decision-making.

MS. NUTTER: Thank you very much. Undersecretary Chang I believe you were next.

MS. CHANG: Great. Thank you. First all thank you very much for inviting me and letting me speak on this esteemed panel here. I just want to maybe first of all couldn't agree more to the previous respondents to that question. I think there is a lot that history cannot tell us. Back to your question about how to conduct future planning in expected load or weather and temperature.

How do we use analyses to inform the future. I do think that the future is much, much more complex than it was in history, so we cannot only rely on historical trends that particularly for example load, and you mentioned load in your question. Many factors that are disrupting the nice, perhaps smooth econometric trends that many load forecasters have been using.

And you know you heard about it already in the previous comments about simultaneity, and a correlation across. And I will just give you some examples. For example, the pattern of electricity usage, just in general will be changing. For example, we're working on electrification of transportation and buildings, and the pattern of grid connected electricity usage is of course affected by installed solar and wind for example.

But also the simultaneous impact of changes in weather related events like climate related events, and how they affect both load and the usage of these renewable generation was significantly will be different, much, much more in the future than it is in the past.

We cannot use historical patterns to really directly inform the future. So we need to disaggregate what that new load forecast means. Heating and cooling loads are going to change over the next decade and beyond. If we pursue as we are in New England, but in general if decarbonization is one of the aggressive goals, that means that heating and cooling loads will increase because we're actually transforming our building sector and trying to use more electricity in heating and cooling.

But of course we know heating and cooling are affected by weather events, so again just to emphasize the importance of what Derek said earlier about the correlation between weather, and load is not as direct as it used to be. We can't just ask you know what temperature we have and then answer this is the assumption on load because there are now behind the meter solar, and solar plus storage, which will be affected by weather, just as load will be affected by weather.

At the same time we're adding buildings and electrifying building usages, and those will also be affected by weather. So I do think in extreme weather events we need to significantly change the way we think about electricity load forecast, and not just load. I mean we can talk more about transmission and generation.

But extreme heat in summers, extreme cold in winters, and in regions where we didn't use to use electricity as much for heating, that's going to change in the future, so we actually not only care about summer heat as that I already talked about, but also extreme cold in the winter just like you saw in Texas.

And then extreme weather and wind conditions that of course will affect our infrastructure which we'll talk more about in the later questions. Thank you.

MS. NUTTER: Thank you very much. Miss Barton I think you're next.

MS. BARTON: Thank you. And I certainly won't repeat some of the same things that have been said by previous panelists that I think are spot on. But I really do want to emphasize that the current deterministic planning methodology that we have used today it works when supply is highly dispatchable when weather is predictable, when peak demand is reached only a few days a year.

Demand as Judy said, really has been a proxy for the impact of weather and temperature, and reliability assessments have been made through contingency analysis, and that's what fundamentally needs to change. If you look at how we planned the system from you know back in time. We've gone from a utility system individual plan to a more regional plan, and quite frankly, wasn't that long ago that it was only factoring in voltage collapse and thermal violations.

To one today post-Order 1000 that has expanded to economic and new policy driven changes. And so it's really to say that the way we plan the system has not been static, and it's important for us to continue to recognize the need to evolve. The cost of failure is quite frankly unacceptable, as Adam had mentioned.

As we look towards a clean energy economy, our customers, our communities are going to be more dependent on the grid, and therefore our expectations on how it's designed have to be different. So you know really one of the tools that can be used is integrated form, excuse me, forecast model. One that's really looking at facilities and the age of their system. You know for example if you really need to take a look at a more local level. What's going to happen within a particular utility? What's going to happen within a region? What's going to happen between regions with these various weather events?

And certainly we can talk on some other questions about how we drill down into that. But that fundamentally needs to be a layered review. Utility, regional, interregional, and that's how we make sure that it's not cost-prohibitive to get through this transition.

MS. NUTTER: Thank you very much. Mrs. DesRoches

I think you're the next speaker.

MS. DESROCHES: Thank you. I again wanted to thank everyone for the invitation today with such a great group. I won't repeat what others have said. I think the answer to the question is we absolutely cannot use historical weather data. We need to take climate projections and embed that into our planning process.

And you know I represent the City of New York, so my perspective here on this question is that we need a consistent approach that full at the distribution level and the bulk level as well as generation. So in fact right now that's a very desperate set of operators and owners, and there's no consistency that's mandated for folks to be planning and designing with the same consistent set of data.

So you know my recommendation is that we look to the national climate assessment. We look to NOAA to provide a range of climate projections that are then utilized across the system, and they can be done in a regional level, certainly the NCA-4, national climate assessment 4 provides regional assessments data as well as what those impacts are going to be even on the electric sector.

In New York State and New York City we have a number of different climate changes efforts that will be ongoing, but we do benefit from having a consistent set of projections. And again those can be successfully embedded into the distribution network planning, as well at the NYISO level, and we can talk about that more later.

But again that consistency across the scales of the system is critical so that we're not having an imbalance of how that system functions depending on what that future climate looks like. Thank you.

MS. NUTTER: Thank you. It sounds like a lot of interesting things to talk about today. Miss Webb I think you're next.

MS. WEBB: Yeah thank you. And thanks to you and the other Commission staff for organizing today's technical conference and for the invitation to participate. I just wanted to you to know at the outset that my remarks today are my opinions. So like I said the Sabin Center has done in collaboration with environmental defense fund, looking at climate risk in the electricity sector. We published a report on the topic in December last year which we provided to the Commission about climate in advance of the technical conference.

One of the points that we make in the report that I think is worth reiterating here that others have eluded to is that climate change really presents a fundamentally different problem than electric utilities and other in the industry have had to deal with in the past.

Of course utilities and system operators have a long history of dealing with extreme weather and the challenges. But climate change as we heard presents the sort of cascading compounding synergistic risks. And so because we have this new challenge we really need to rethink old planning approaches and suggest them, and also develop new planning approaches. So I would wholly second the previous speaker's comments that we should be integrating climate projections into existing planning processes.

We can talk more about this in other questions, but you know the quality and availability of the climate projections, particularly downscale climate projections that show impacts regionally and locally has improved significantly, and many are already publicly available, and there are more that could be developed.

But simply integrating to some of the previous speaker points, simply integrating those forward looking projections into existing planning processes is unlikely to be sufficient. We're going to need to rethink some of those existing processes around for example how we measure average generator outage and availability, assuming a consistent average across every hour of the year doesn't necessarily make sense when we know that extremes, particularly extremes in temperature, can affect those things.

So integrating those adjustments into the existing planning processes. And also thinking about new specialized planning processes that are more -- are better suited to dealing with climate change along the lines of a colleague from PG&E described. That sort of more specific climate resilience planning will be very important.

MS. NUTTER: Thank you. Miss Barton your hand is still raised. Did you want to speak again?

MS. BARTON: No. Sorry about that.

MS. NUTTER: And actually I have a follow-up question kind of based primarily on what you said and what some other people have said. Some planners are changing for example layered reviews on utilities, regional, so I was wondering if you could share with us a little more detail on how AEP has started down that road, and experiences you might be able to share with us.

MS. BARTON: Sure. You know one of the things that we did with respect to our recent climate study is look at a report that was done by Perdue University, and really taking the impacts associated with climate change in terms of what does it do to temperature? What does that due to demand?

What really needs to be done as previous panelists have mentioned is that each should be really taken to a different level. We need to continue to use deterministic planning, but we need to basically use probabilistic and static methods to better manage those risks.

And let me give you maybe an example of how this can be done. If you think about it from the standpoint of reviewing the system. And I mentioned you take the view of what's happening at the utility level. So if you factor in climate, weather, demand, implications, what facilities have an increased risk, of failure. What is the restoration time associated with that?

What will it mean from a demand perspective? What other facilities will it impact? And so let me just give you a couple examples on the AEP system. So if I were to lose a transmission tower in West Virginia which is really going mountaintop to mountaintop, it can take me over three months to restore that transmission tower.

If we're in Oklahoma, and it's very flat it might take me only a couple of days. These are the kinds of things that really need to be all thought through, and I think at the individual utility level companies can determine what's going to happen to their system. So for example, the systems that we have are a culmination of assets that we have been building for the past 100 years.

And so, they are not all built to 2021 standards. Some are billed to 2030 standards. How will they do in different climate scenarios? So it's really taking a probabilistic view. What you would also do I think at the next level is take a look at similar questions at a regional level, again.

What are the changes that you can expect within your region because certainly in the Midwest the answer to what's going to happen from a climate perspective is going to be very different than it would be for California, or what it would be with respect to Florida.

So putting that all into perspective is important, and then asking ourselves you know how do we ensure resiliency? How do we make sure that we have the necessary protections on black start generation on black start paths? What will happen to our black start paths?

I think all of the planning that we want to do in the world is wonderful, but we also have to make sure that should something happen because we came awfully close in Texas. When you are two one-hundredths of a frequency deviation away from losing an entire interconnect it goes to show you how important we have to -- or I should say the level of attention that we have to place on restarting the grid.

And so thinking about redundant black start paths, making sure that our black start generation is the most resilient of our generation, while asking ourselves the question is load shift an acceptable tool? It has always been an acceptable tool in the past. Will it continue to be? And then thirdly as you go to the interregional view, I think that it's really important to -- and we learned this from Storm Uri as well.

The more the regions can lean on each other for assistance, the better positioned they'll be. The more we can -- just think of the geographic diversity that you can get if you're in a future which has a lot more variable resources. While your variable resources may be adversely impacted within your region, or within that local utility, but going to the next RTO all of their wind resources are still spinning.

Having those strong interconnections, making sure that you can lean on each other is going to be part of the no regret solutions that I think when we think about planning we need to focus on. And I think that that also goes a long way to making sure that it's a cost-effective transition as well.

MS. NUTTER: Thank you very much. Mr. Stenclik would you also like to respond to this?

MR. STENCLIK: Yeah I'd like to add on to Lisa's great kind of conclusion and comments there about transmission and regional coordination because ultimately transmission should be viewed as a reliability asset. Often times we get stuck in a mindset that we need more capacity, or more skin on the ground in terms of generation to meet some of these risks, the transmission is a key reliability contributor.

And ultimately that just comes down to regional coordination. It could mean more interregional transmission. It could just mean a change to the institutional way we view climate, and the way we do resource adequacy analysis, the way we do reliability planning.

The more that we can link regions together, you pick up on geographic diversity, not just in the wind and solar resources, you pick it up in terms of the load, and ultimately on the weather themselves. Obviously, if you look at the ERCOT event MISO and SPP were also struggling during that weather event, but ultimately could support one another, and also receipt imports from neighboring regions.

If you also look at pricing data during those events while the Midwest was seeing extremely high prices and shortage events. If you look further east it was a rather normal day, so the ability to add more transmission, and more capability to share resources, again not just by adding more words, but there's institutional barriers here as well and climbing barriers that need to be addressed.

Ultimately, when we think about reliability as an industry we need to rather jog about cohesive regional planning, or full interconnection planning to make sure that we're fully leveraging that capability for reliability.

MS. NUTTER: Thank you very much. Both of you have given an information answer in that pocket. Miss Hogle did you also want to speak to this one?

MS. HOGLE: Sure. I want to build on what Lisa and Derek said too and comments we heard earlier because I don't want to underscore how important you know I think it was Susanne that said that consistency of data that you're using right? In California you know we're using the RCP 8.5, and we're also using the California climate assessment data.

We know that that's being applied throughout the state by not only the investor and the utilities, but our local communities as they do their resilience planning. So I think having that shared dataset is really helpful and important. And then we are looking at the entire chain right -- transmission, distribution, generation.

And you know for us in California as Lisa was mentioning around variable resources, we do have to think about what the impacts of climate are going to be on our generation and our supply because obviously, you know, if you're in the middle of a heatwave it tends to be dryer, and there could be less wind, so maybe you don't have as much wind, or if you have really heavy storms, and you have several days of that you're not going to have the same solar output that you had.

So it's very complex in terms of everything that you need to consider, but it is important to understand and consider the entire landscape that can have an impact as well as you know that consistency of data in terms of what we believe the potential scenarios could be that we should be planning around.

MS. NUTTER: Thank you very much. So now we've been talking about shared datasets. I was wondering if Doctor Easterling you would like to talk about that since you might be one of the sources for some of that data?

DR. EASTERLING: Sure. So just a little background. I'm the Director of the National Climate Assessment Technical Support Unit, and so we do develop the climate scenarios that are used in the national climate assessment. We develop the ones for the NCA-4 and the NCA-3 using mainly simulations from the major climate modeling groups from around the world.

So when the intergovernmental panel on climate change does their major reports that come out about every six years or so, the major modeling groups have a set of scenarios they use to produce simulations, and then put it into a big database. Those are available for anybody to use.

For the NCA-4 we used the couple modeled with our comparison project 5, CMIP 5. So the modeling simulations to produce sort of a large scale climate scenarios of using RCPA point 5 and 4.5 mainly. And for the upcoming NCA-5 we're going to be relying on CMIP 6, which is the latest version of all the different climate modeling groups simulations, and these total you know like many dozens of climate model simulations, and then we also use what's called statistical balance scaling, divert the California assessment was mentioned.

We're using LOCA, the localized -- I'm trying to remember what the acronym stands for, but anyway it's a statistical downscaling product that we have used. Here we go, so we can go to the next slide. So for NCA-4 we used CMIP 5 and our derivatives.

So we used LOCA, mainly RCP 4.5 and 8.5. We did include some material on 2.6 If you remember the IPCC put out a report on warming at 1.5 and 2, what the impacts would be. For NCA-5 we're just now getting started on a report, it's supposed to come out every four years. You have a little bit of delay in getting going. We're going to focus on CMIP 6, and likely the LOCA 2 downscaling.

There are a number -- somebody mentioned there are a number of different methods out there for downscaling, so basically if you can go to the next slide. This shows you sort of the raw GCM or global climate model output for this is the annual temperature change.

At the end of this century from the climatology from the end of the last century, it's very smooth. You don't really see a whole lot of detail except to see that you have the largest warming going on at the highest latitudes, in the polar regions, not quite so much warming as you get down into areas like Mexico. Still quite a bit of warming through, but you don't feel a lot of the sort of the regional detail that you'd like to see in scenarios.

So if you go to the next slide we used localized constructed analogs. This is a specifically downscaled product from Scripps Institute of Oceanography, and it gives you a much finer spatial resolution in terms of sort of where you can resolve things like you know the Rocky Mountains, the Appalachian Mountains, things like that that are very important because they do have an impact on.

What we use these for was basically looking at scenarios of extremes and I'm going to show you one example, and that's the next slide. Okay this is from LOCA for the NCA-4, so we did this about three or four years ago. But you could see there's much more detail in terms of where we're going to see these changes.

You can actually see the Rocky Mountains, and to a lesser extent the Appalachian Mountains and in the mountains in Mexico where you can see this is the change of the number of days over 90 degrees at the end of the century. And it's quite large in terms of the scenarios. So we produced these for the use by the authors and national climate assessment, you know, we feel like they're sort of state of the art, probably the best that people can use right now.

And we are going to make these available to the general pubic on the website once we've gone through an analyzed all the schematic simulations and the downscaling and produce these kinds of products.

So and one thing I actually wanted to pick up on that Judy Chang said. Climate change is not going to be sort of a smooth monatomic trend. You've probably all seen the global temperature Time series that shows into the end of the century sort of a smooth increase in temperature. You have to keep in mind that that was produced using an average -- what we call a multi-bottle average, so it's an average of probably 50 or 60 simulations.

And so what ends up happening is all the natural variability within the temperature changes and other changes within the climate system are kind of averaged out, and all you do is you get the forced trend that is there from using RCPA .5 or 4.5. But climate change is going to have bits and starts in reality.

And it's going to you know I did a paper on --

you've probably heard the so-called hiatus in global temperatures. And we did a paper that showed that those sorts of slowdowns in global temperature and regional temperature are going to happen in a climate system because we have a forced trend, which is the increase in carbon dioxide and other greenhouse gases, but we also have natural variability that occurs due to things like volcanic eruptions, changes in El Nino, La Nina and things like that.

So keep in mind it's not going to be a linear trend, and also if there are thresholds that are going to be passed as we have an increase in temperature and so you know that's something that when you're looking at load forecasting and things like that you have to keep in mind in the future.

MS. NUTTER: Thank you very much. That was a lot of good information. Kind of as a follow-up to that in LOCA there's the one from -- I mean somebody might be able to respond on this. Is what you're describing something that sounds like that you could use, or do you have any potential feedback about this. Mrs. DesRoches I was wondering if you would like to maybe respond?

MS. DESROCHES: Sure thanks. So in New York City we have down sampled climate projections through an academic body called the New York City Panel on Climate Change. But it provides very similar information to what David was just showing, so days over 90 degrees, sea level rise projections in a range of RCPs et cetera.

So we've used that data for the last over a decade or so to do climate change planning in New York City as well as collaborating with partners like Con-Edison, or local distribution provider, and in NYISO to really take that data that comes from the climate scientists, and figure out how to exactly to embed it into the existing planning, but I think point well taken, the existing planning is only going to take us so far.

So again I think you know from my perspective, we've been using this data for over a decade. It's very useful. Is it as precise as our engineering community would want? No. You have to choose a direction. You have to decide how conservative, and I think Miss Hogle using the most conservative for our electric network is critical, that we you know take a conservative approach.

We look at those high end projections and you know we also look to use scenario planning which I know we haven't talked about, and we may discuss a little bit later to really get at those swings in what's going to happen. So as we saw in Texas we certainly have also seen polar vortex events in the northeast.

Those really super, super cold days. They last you know sometimes a week. We have to plan for that as well as you know a three or four times the amount of days over 90 degrees, at least that's where we'll be in New York City. So again, we have a long history of using this kind of data. Not just in the electric sector, in transportation and otherwise to do successful adaptation planning.

MS. NUTTER: Thank you very much. Mr. Stenclik I see you would also like to respond.

MR. STENCLIK: Yeah thanks. I think David's response for me at least highlighted the importance to really link power systems planning and climatology and weather modeling in general. I think what happens a lot of times I'm not a climate expert. I'm not a meteorologist, or an expert in weather, but it's so foundational to the work that I do every day.

I rely on others to really translate, I mean the work that David's doing and getting into the inputs that I need for my powered system modeling and simulations, namely correlated wind speeds, solar radiance data, temperature, precipitation. Like the inputs that go into how the power system actually operates on a chronological hour by hour basis is critical.

So I just think there just needs to be better linking of the power system planning codes to have more of a background in meteorology and climate, and vice-versa with the climate community to have a little bit more background in the power system operations. That's going to be critical.

I think the industry has done better in the past several years. I think we have more tools at our disposal for many years of chronological solar profiles and wind profiles. There's a couple of datasets out of NREL, the National Solar Radiation Database that can provide solar power production profiles across the country.

Likewise for wind, although I'm on a much smaller time scale in terms of historical weather. And that's the type of weather datasets we need more of in the industry. Many years of time synchronizing consistent datasets around wind speeds, solar, load, and ambient conditions I think ultimately that's kind of the next step.

We can do better as an industry even without a climate trend, and then the difficulty will be having a climate trend on top of that. So I think for me it's the gap is going one step further and taking that climate trend data and getting it into the format namely hourly, chronological wind or solar production profiles. That's really a big gap that I see.

And then also on the load side I think FERC 714, or FERC form 714 is kind of the go to source for the load data if you're going to do a large regional or national study, and I think that can also be improved, have more insight on weather conditions and distributed generation and likewise.

MS. NUTTER: Thank you very much. Dr. Easterly I see your hand raised.

DR. EASTERLY: Yeah. I'd just like to pick up on something that Derek mentioned and that's so when we produce these scenarios, we're trying to have a standard of things like days over 90, heavy precipitation, things like that. And it would be really useful I think for us to be able to interact with people like you guys that really have a use for these things, and putting them into your forecasting models, as to what variables you really need.

We produce, you know temperature and precipitation, downscaling mainly if you're looking at statistical downscaling, it's mainly temperature and precipitation. If you look at what we call dynamical downscaling that's basically wanting a regional climate model for general climate, global climate model. You can get a lot more of these variables like wind and things like that.

And mostly what we do is temperature. I think LOCA does humidity as well, or maybe one or two others, but there may be some variables that you guys need that we could pull out of the general circulation model and global climate models and downscale that aren't currently being done.

So that's something that I think I could see you know as a really useful sort of collaboration.

MS. NUTTER: Thank you very much. That sounds like a good idea. Undersecretary Chang I see that your hand is also raised.

MS. CHANG: Yeah I just want to chime in because first of all you can see already from this dialogue how important this kind of discussion is, and I don't think we've had this kind of discussion until now. At least not at the scale that we need to at the national level, regional level, and you know local level.

First, I'm going to just summarize a few things, and one is that absolutely incorporate the best available climate data in planning, system planning, electric system planning. And that's very broad, okay we can talk about that. And then the data as David pointed out, like what type of data do you want, and what granularity?

What geospatial level? We all need to have like a sit down and really roll up our sleeves kind of dialogue around that because what you know Lisa might need is very different than what New York City might need for example. So I think we need to view that, and then the third -- the sort of several layers of how climate affects the power system, and I don't want to -- I want to try to reduce the complexity because when I listen to what you know Lisa was saying earlier, this is very complex.

So I want to reduce the complexity a little bit. One is that there is all this sort of wind, solar load which is how does climate, change in climate, and weather events, or weather related events affect all of those things? And that itself is complicated enough.

And NOAA has data on that, NREL has data on that. But you know as even if we didn't have climate, we still have to work on that very, very well. And then the other -- all distinct and separate from that is the physical impacts right, the impact of climate on the physical assets, the physical generation assets and transmission distribution because you know you could take wildfire as an example, or any other severe storm as an example.

We may not in the future want to place transmission lines along the same corridor. We may need more diversity in the future. The most important thing I think to think about looking into the future as far as load forecast is the assets we build today are meant to last 40, 50, 70 and maybe even 100 years long, so the climate forecast is not just for the next year or 10 years, we have to think about when we make these investments you know multi-billion dollar investments, what they're going to look like 70 years from now because most of them will actually still be there, or parts of them will still be there.

And that's a huge deal because we don't know what the climate will look like. So then we can talk you know in later questions about scenario-based analysis or stochastic and probabilistic analyses, but I think there's two separate things. One is sort of load and wind and solar forecasting how it affects usage power.

And then the other one is these weather events will affect our assets physically, like the investment strategy will have to actually change and maybe even you know Lisa eluded to this before. Even the reliability criteria may have to change because we may not want to build a whole bunch of things all subject to the same wildfire risk, you know they're all too close to you know the highest drought or area.

So I think there's two separate pieces here, and that shows why this kind of dialogue would you know folks like David and your shop is really important because you may not know exactly what form the data we want -- we meaning the power sector wants, and we might not know how to translate that data into something that's useful, so I think this dialogue is extremely important. Thank you.

MS. NUTTER: Thank you very much. I see that several of you have raised your hands. Miss Hogle I think you're first.

MS. HOGLE: Sure. I just wanted to raise on you know kind of the availability of data. David asked the question at the end is this helpful, and I think the answer is always yes right? Availability of data is critically important and it's always helpful. I know for us at PGE we're very fortunate that California has invested in you know providing this data.

And it's downscaled in a way so that it's actionable or useable for us. And where we you know don't have what we need we have the ability to reach out and obtain that because we have the resources to do so. So an example I can give you is recently we partnered with Argon National Labs to understand what the future Diablo wind patterns would look like in Northern California, because that helps us project what our future wildfire risk is going to be, you know, out to 2050.

But again we're very fortunate because we have the resources available to us to be able to do that, but that doesn't exist everywhere and I just want to raise kind of the equity lens and consideration into this discussion because you know we're one part of an entire kind of critical infrastructure ecosystem, and water infrastructure, transportation.

You know as I think Lisa mentioned is more and more sectors become dependent on the grid it's critical that we have this, but we also have to understand that we're only as resilient as we all are together, and so I just think the more we can provide data, and the more you know FERC and for us in California we're seeing the CPUC do this you know kind of providing a blueprint as to how we may do things, and being transparent about it.

And you know so that folks can look at that and be able to say okay, I need to be doing the same thing. Perhaps I could use that as an example and leverage that as I do my own adaptation planning. I just think it's really important to recognize that not everyone has the same resources that we have and that you know we're only as resilient as we all are together right?

We're only as strong as our weakest link. Thank you.

MS. NUTTER: Thank you very much. Miss Webb I believe you're next.

MS. WEBB: Yeah thank you. And so Miss Hogle made an excellent point about you know opportunities for collaboration that utilities and system operators and others in the industry should be exploring where they have the opportunity. I think there's been some great examples here in New York, Con-Edison our distribution utility when they were doing their climate vulnerability assessment partnered with Columbia University scientists to develop the specific data that they needed to feed into that analysis.

As we said that's not possible for all utilities, but certainly the utilities that can do that their experience offers learnings that others can take onboard and move forward with. I also just wanted to pick up on something that Undersecretary Chang said about the sort of physical risks to physical infrastructure, and how that influences sort of long-term investment and planning and decision-making around investment.

You know there has been I think on occasion a reluctance by some in the electric industry to rely on forward looking projections because they are very far out into the future, you know, they're not sure of anticipated climate conditions in 2050 or beyond.

And they are not absolutely 100 percent certain. But to Undersecretary Chang's point, you know utilities and system operators and others are making investments in long-lived assets, many of which may still be around in 2050. So the fact that these projections are far into the future, doesn't undermine their usefulness, and that if anything it actually increases their usefulness as a sort of input into the decision-making tool.

And not only does factoring those forward-looking projections into those investment decisions sort of help to design more resilient infrastructure and sort of build in resilience so that we can avoid the need for future retrofits or hardening, it also has other financial benefits you know we're seeing increasing concern within the financial and the insurance communities about future climate risk.

And so utilities and others that fail to integrate those climate considerations into their investment and design decisions are likely to face higher insurance and burrowing costs going forward. So there's a lot of reasons to take this forward looking future focused approach, thanks.

MS. NUTTER: Thank you very much. Miss DesRoches I believe that you're next.

MS. DESROCHES: Thank you. I wanted to follow-up with Undersecretary Chang's comment there on the two paths right -- the existing vulnerability as well as the forecasting into the future and just point at a couple of examples that we have here in New York State, New York City.

The NYISO who I think is on as an attendee did a climate change forecasting effort where they did both. They looked at what is the future climate going to be like, and how are we decarbonizing? And what is that future energy look like? And they have produced demand forecasts for use by you know anyone in the NYISO region and beyond that looks out about 20 years with both of those pieces in there.

Now it doesn't have the vulnerability of the existing system, and I think that that is something that we really have very little understanding of when those towers were built, when those underground cables were installed, how vulnerable are they now to climate change? And how much does that vulnerability increase over time?

But from a forecasting perspective, the NYISO has been for the last few years at the urging of several stakeholders, including the City of New York, produced these forward looking projections of our demand. So to Derek's question of like we need these you know solar and wind load curves, we actually in New York State coupled that with what are the impacts of climate change, how is the temperature changing, and what are we seeing in the future.

Which I think is something that should be done again -- my point earlier consistently, across the nation where we have interdependencies. The other thing that I wanted to point out, and I believe Miss Webb brought this up. The city has been working very closely with kind of the same for the last since Sandy, Hurricane Sandy, so that was in 2012.

So we're coming up on a decade, really to look at what are these two questions. What is that vulnerability today of these assets? What does the future climate look like? And how do we base our implementing plan within their own assets and with their own systems understanding vulnerabilities today, and as they project out in the future.

All that information is public and will be updated on a regular basis which leads me to my other point. This is all iterative right? And so you know, I think that when we -- I think that we shouldn't be looking for the perfect planning process. We have to adapt the planning processes we have today, and we can't wait for that to happen because that could take a really long time to come up with the next planning type of planning process.

So New York City has produced climate resiliency design guidelines where we take the climate projections. We actually issue them as data over time for engineers and architects to use in all planning processes and capital expenditures. And we say you must build to this from a heat perspective, from a precipitation perspective, and sea level rise.

And so is it the perfect tool? Absolutely not, but it really says okay, as of today we're no longer building with those historical trends, and you can actually take that projection data and translate it into a more static points in time -- datapoints in time that will make those assets more robust.

I think this needs to happen at least at a regional level, which I know is very complicated and difficult to do. Certainly across the different regulatory entities that construct that we have, but there needs to be that kind of guidance so that people can start today and not you know wait until that planning process is perfected in order to start integrating climate change thank you.

MS. NUTTER: Thank you very much. Doctor Easterling I believe you're next. Doctor Easterling if you're speaking I believe you're on mute.

DR. EASTERLING: I was muted. So I want to follow-up on a couple of things. One of those was you know there are a lot of users in small municipalities, probably small utilities that can't afford to pay you know somebody to develop the scenario for them to use in their planning purposes.

And one of the things that we're looking at in NOAA, I know we started looking at in the past six months or so is trying to take some of our climate model out, because we do have a number of state of the art climate models within NOAA, and actually develop a tool that users can come in and take a look at climate scenarios for RCPA .5 or 4.5, and use those in planning.

You know sort of you know it's not the sort of thing you would get if you went out and paid $500,000.00 to some company to give you a scenario, but it gives you a basic tool to be able to get some idea of what might happen.

So you know one example is looking at let's say Wilmington, North Carolina.

They're a small city. They can't afford necessarily to pay somebody for sea level rise scenarios, but we do produce sea level rise scenarios. Wilmington's on the coast and it's you know developed as sort of a website and web-based tool they can use, so you know that's something that we're looking at now within NOAA is to be able to produce that sort of thing, so that smaller users, people that can't afford to go out and pay somebody, at least they have somewhere to turn to be able to use more planning processes. Thank you.

MS. NUTTER: Thank you very much. Miss Barton your hand is raised.

MS. BARTON: Yeah. So I think she addressed the cost and the difficulty associated with individual companies looking at this. The RTOs are very well-positioned to do this. We can use the RTO planning process to quite frankly develop just a number of scenarios, as I think was mentioned earlier by someone. We cannot sit there and harden everything. The grid is not perfect today in that will not be perfect 30 years from now.

But we can get better in terms of how are we making decisions, where do we route lines? These can be important bits of information for state regulators as well.

Maybe you don't want to be on the top of the mountain for having your transmission assets.

Maybe you want to take a different path. These are all the kinds of things that are really important, but I think starting with the RTOs, and using downscaling to get the RTOs to focus on it, and getting the larger utilities to focus on it you will get significant coverage, and significant attention to these probabilistic views.

MS. NUTTER: Thank you very much. Miss DesRoches do you have anything that you wanted to say?

MS. DESROCHES: Sorry my hand was still up from last time. Thanks.

MS. NUTTER: Is there anyone who would like to respond further on any of the topics we've been discussing here? Okay. I think we're ready to move to the next question. I'm going to turn it over to Ena to introduce the next question.

MR. AGBEDIA: Thank you Louise. The next question we've already discussed a lot of it, so just a little segue into it. The question is Are there best practices for developing probabilistic and stochastic methods for estimating these typical planning inputs, including through the use of expert developed climate scenarios such as the Representative Concentration Pathway scenarios for baseline CO2 projects developed by the intergovernmental panel on climate change? I'll direct this question to Doctor Easterling.

DR. EASTERLING: Yeah we worry in fact a lot about it. You know one thing that we do to obtain within these downscaled simulations, we realize the larger is you know these are made up of a number of like 50, 75 simulations. So when you run a climate model you know you start with slightly different initial conditions, and when it runs out through the end of the 21st Century you get a slightly different result.

So you begin to bound sort of get an idea of the uncertainty, so if you're looking at you know how the climate is going to evolve in the 21st Century, you know there is two major sources of uncertainty. You know there's the model of uncertainty, and then there's the pathway is it going to be RCP 4.5, you know where we have emissions, continued in the middle of the 20th century, continuing to increase and then kind of level off.

Or is it going to be sort of the business as usual which is the 8.5 where we have emissions just continuing out to the end of the 21st Century which is very sort of risk-based planning, but is that realistic you know? My expectation or hope is that we're going to be closer to 4.5, but I may be wrong. But what you do is you can get you know an idea of uncertainty by using the fact that even LOCA has you know you don't get just one time series of temperature. You know you get a number of like 30 times series because you used a number of different models in there.

So you can use that to run your whatever model your impact model is and get an idea of the uncertainty of it as well. So which is really important you know, because if the uncertainty is really small you can have a lot more confidence in that output that final result and that you have a very wide uncertainty.

MS. NUTTER: Thank you very much. Does anyone else want to respond to this question? I know we've talked about it a lot. Okay. I think we've got that one covered. Ena would you like to introduce the next question?

MR. AGBEDIA: Sure. So the next question is are there expert-developed climate change scenarios, including downscaled ones for smaller regions, that can be incorporated into the planning process at all relevant levels? What additional information if any do utilities need from government, academic, or other entities with expertise in climate change and meteorology to develop effective vulnerability assessments? I'll direct this question to Miss Hogle.

MS. HOGLE: Thanks. I mean I think that one thing is a kind of shared understanding and discussion around risk tolerance, and I think I mentioned that earlier. The California Public Utilities Commission has directed us to use the RCP 8.5 pathway, and so in our analysis and so you know we have that kind of benchmark, and that's the data that we're incorporating into our decision-making.

And then you know what you do with that data you know, that's kind of another set of decisions that need to be made right, and planning that you need to do. So for example, you know if we want to update our design standard for heatwaves to be one that's updated for you know, heatwaves that we might experience in 2050, or a heatwave that we might experience in 2030.

You know that's where you get into that risk tolerance, what it is that you want to plan for. And then also on an annual basis incorporating the results of your current vulnerability assessment into your -- you know the annual asset management plans that we do, and then of course before you put something in the ground you're going to want to make sure that it's going to be built to withstand the 40, 50, 60 year lifespan, but utility assets typically enjoy.

And then we also you know seek to incorporate the results of our analysis in our risk models, so we understand what kind of the overall vulnerability is but then we need to incorporate this into the risk models to then understand what the impacts and the consequences are, you know what's the impact to the risks in terms of frequency, and then what are the consequences from a customer perspective if these were to materialize?

And then finally I'll just note you know we use it for decision-making in terms of our extreme weather planning right? So we conduct drills, and we have just like all utilities, you know, very robust emergency response function that is prepared not just to respond to emergencies, but also in advance kind of drill through those.

And so we're going to use this data to inform different scenarios to plan for kind of that cascading compounding event. So those are things that we can do, but I think more broadly, you know, it will be helpful at a regional level to start kind of doing that together and aligning upon what we think our shared risk tolerances, how these things would play out.

You know, kind of the way that we do resource adequacy today for example, you know doesn't take into account kind of the different guidelines in the states and you know what regional or compounding effects of a broad swarth of the country could look like.

So I think that's something that needs to be done you know beyond we're already doing these in California, but it will be helpful to expand upon that on the regional level which I think a lot of my colleagues have already kind of mentioned.

MS. NUTTER: Thank you very much. Is there anyone else who would like to speak to this question?

MR. STENCLIK: I guess I can jump in on that very quickly here. I think one thing in terms of additional information. I've brought it up once before when responding to David's comments, but just the ability to translate that climate trend data into the raw inputs into that are used by power systems, planners, for resource adequacy analysis, for higher peak planning, all that type of work.

I think there's a gap there, and I can't tell you how valuable tools like the national solar radiation database, like you know, can use no matter where I go to do a study for a client. If I'm in California or in New York, I can go into a consistent tool to download the data in a very consistent way across many years of chronological data, and it's not just again the weather data, it's the weather data coupled in a way to translate that to production profiles that ultimately you use on the power sector.

So I think David, you've brought up the tool that you all are working on that would let you go in and kind of develop a scenario using the larger dataset, the larger modeling tools that you already have available. I think tools like that are critical because you know somebody brought up before, and David maybe it's you, about how a small utility, or a small entity or developer might not have the funding to go do a full climate study.

I can't tell you how many times we've gone out to partner with somebody to do something like that and it's like well it's great, but it's three -- the total budget of the power system side on the weather.

So having these national datasets are really important, and are a way to not only allow practitioners to implement this data, and implement these trends, but do so in a way that's consistent from region to region, and especially when you start to go not just to do a study for a utility in New York, but say well how does New York look using the same data in ISO New England and PJM and Ontario, and making sure that you're not just making generic assumptions outside of the region of focus, but you're using consistent time synchronized weather data across all those regions.

I think it's important for just weather data generally, you know, so it's certainly obviously the climate change issue it's important, but it becomes increasingly important with the resource mix change and climate change as well.

MS. NUTTER: Thank you very much. Undersecretary

Chang I see you raised your hand.

MS. CHANG: Yes. I just wanted to echo how important that is to have a consistent set of national and regional and detailed data. Just to give you an example you know we already talked about how wind and solar and load are all related to climate and weather, but also hydro, and for all the regions that rely on hydroelectric supplies, you know severe drought is going to affect that, severe snowfall in the winter is going to affect that.

And all of those things I think will be significantly important. It has always been important in the past, but now I think with more dynamic changes in the future it will become even more important. Now Massachusetts has engaged -- I just want to ask because some of the previous questions that were raised by other panelists, we have been engaged in research teams to downscale climate projections, temperature and precipitation for two of the RCP scenarios, 4.5 and 8.5 based on global climate circulation models.

I do think probabilistic methods for estimating certain parameters will be important but it's really it's more important to actually understand when do we need it and how are we going to use that information? Otherwise as you can imagine using probabilistic approaches you can just get stuck in never-ending analyses.

So I do think it's important to think probabilistically just like many panelists have said before. It's not only the average that we're planning against, its actually some of the extremes. And even in that question how extreme shall we go out? Is it like a 1 in 100 years, or 1 in 10 years? You know we have a tradition of planning to 1 in 10 years in the power sector, but what does that actually mean given the climate uncertainties going forward I think is really important.

And just as the insurance industry will tell us, you know the more uncertainty there is the more valuable insurance is. So then we have to think about what kind of infrastructure investments are like insurance products for this industry. And I would say you know Lisa had mentioned before transmission can be seen as an insurance against severe events. Storage, or different types of storage in different parts of the country can be seen as insurance against severe events.

So I think that will definitely affect the way we plan into the future. And then I want to share a few things with you if you don't mind pulling up the slide, and if we can go to slide 4. I don't need to get into all the details in the other slides, but I prepared three slides which I think will be interesting because and as you know as staff pulled that up.

Will I be able to see it if you pull it up? I don't know.

MS. NUTTER: Yes you will one second.

MS. CHANG: Okay. No problem. I just want to say that we have a resilient mass action team in Massachusetts. It's an interagency team working to implement the state hazard mitigation adaptation plan led by my office and the Massachusetts Emergency Management Agency, which is a state level like FEMA but MEMA.

And staff by climate change coordinators from each executive office, and they've been working for the last year and a half on this effort, and through agency working groups they hold advisory groups and public comments. The RMAT, we call it the RMAT, the resilient MA action team has developed an easy to use interactive web-based tool that utilizes the best available climate data that we have, and some of that came from NOAA.

And provide immediate results and recommendations to inform the second piece that I talked about earlier which is the physical infrastructure that we build. And this is actually being proposed -- it just got launched as a data model from data tool just a couple of months ago. This tool is one of the very first of its kind.

It's of course using site specific questions and location information and provides specific projects, a preliminary climate risk rating and recommendation, and how to increase the resiliency of project design through targeted planning horizon return periods, design criteria and methodologies for utilizing state-wide climate data.

With this information we can better inform climate smart capital planning so it's not just the utility industry, but it's all capital planning, particular infrastructure, and ensure our investments are you know assessed not only with dollars, but also all the investments made by states or states that have funded certain projects, or were thinking even with ratepayers money so they're regulated assets, to increase our climate resiliency and to better understand the vulnerability, and to serve to enhance the local resilience that all of our infrastructure will face.

You know next slide please. I just want to share with you a few slides here. It kind of looks like this. This is the input page where a user would input specific project information. It has kind of a question and answer kind of a thing. You know you get to say what the project is, where the project is located, and a whole bunch of parameters about the project.

And then the next slide please. It will give you -- I know it's very hard to see, and I don't mean for you to read everything, but the idea here is it gives an output about the climate related risks associated with certain infrastructure investment, or it could be a building, it could be a bridge, it could be anything that's you know comparable investments.

And they will give the user not only the risks. You see sort of the yellow and the red, you might not have an easy time reading the words, but the level of risks associated with climate. And then it gives some suggestions about how to mitigate that exposure which is on the right-hand side.

I just want to share this with you. It's a whole bunch of very exciting new features were added. We're now doing a stakeholder sort of beta testing process with people who will be using this tool. We may also be using this in permitting of certain projects in the state, and business you know above and beyond energy projects.

But we are also thinking about potentially using this type of tool for siting purposes for energy projects. So I just want to pause there. Thank you and you can pull down the slide, thank you.

MS. NUTTER: Thank you very much. Doctor Easterling I believe you're next.

DR. EASTERLING: Sure. So I just want to mention so how to arrive at the extremes came up a little bit earlier, and so we've heard in NOAA atlas 14, that's the atlas that we produce that is used by civil engineers to look at okay, a design to the 100 year 24 hour landfall amount, or something like that.

So if you get a location that says you know based on current data the 24 hour 100 year landfall amount is X. It may be six inches or something like that. But one of the more robust signals that we see in climate models for the future is an increase of atmospheric water vapor because as temperatures go up, the amount of moisture in the atmosphere will go up, and that moisture is then available to rain out as heavy rainfall events.

So we've seen an increase in that. Especially the northeast has been probably the hardest hit in terms of an increase in the landfall amounts. NOAA atlas 14 has you know for each location has a sort of a okay what's the 10 year, 24 hour rainfall amount. What's the 24, the 20 year, the 100 year and so forth.

And these are used by several engineers for design. Well DOD, Department of Defense was very interested in how these threshold amounts might change in the future and so a colleague of mine and I had a project to basically take the atlas 14 and then use climate models to provide an estimate for what we think those rainfall amounts will be in the future, or 20 years in the future, 50 years in the future, 75 years in the future and so forth.

So you know our current 24 hour 100 year rainfall event in the future it may be six inches now, it may be 8 1/2 or 9 inches in the future for a given location. So we actually have produced this, and we now are about to put out where you could actually go in and it will bring up you know our map, and it says okay, I want to look at New York City.

Okay what's the 24 hour 100 year rainfall amount going to be in 2050 or 2075? So we use climate models, basically the increased atmosphere of water vapor to try to estimate how those amounts will change, plus you get an uncertainty based on the fact that we use multiple climate models.

So it may be what's now 6 inches may be 8 inches plus or minus a half an inch. So I just wanted to kind of mention that. That's another tool that we are developing, probably not as much for the power industry, but I guess with hydropower because some of those amounts are actually PMP, probable maximum precipitation which are used in dam design.

You have to have a spillway to be able to account for that actual amount of rainfall you might get.

MS. NUTTER: Thank you very much. Mr. Stenclik your hand is raised. Do you have a follow-up statement?

MR. STENCLIK: My apologies. I must have not taken that down.

MS. NUTTER: That's fine. In that case I'll go to my colleague for a question you wish to ask Rahim would you like to speak?

MR. AMERKHAIL: Yes thank you. So this question regards the downscaling. What I think I've heard from a couple of panelists now is that their state took a very proactive role in taking raw data from where it's generated and translating it into data that's useful to the utility, and I heard Doctor Easterling offer for those utilities that maybe don't have it, a state that has the wherewithal to do that perhaps, or the interest that they could step up.

So I just had a quick question. Is there a way for Doctor Easterling, is there a way for utilities who may be watching this webcast to contact NOAA and explore the options for getting this type of data directly from NOAA? Thank you.

DR. EASTERLING: Yeah. I mean I guess I would be the first person to start with and I can certainly direct people to the right place. And Adam Smith, Adam works with me here in Ashville, North Carolina, at NCI, so that would be another connection into NOAA is Adam as well.

So I don't know if you can put my email address up there, or something like that and I'll be glad to if I can't answer it or provide that information, I can certainly point you to the right person.

MR. AMERKHAIL: Thank you. That's helpful thank you.

MS. NUTTER: Thank you very much. And I believe we might have some questions from some of our Commissioners. Do you want to let Commissioners have questions that they would like to ask?

COMMISSIONER CLEMENTS: I have a couple questions if it's appropriate to pop in. Can you hear me Louise?

MS. NUTTER: Yes.

COMMISSIONER CLEMENTS: Great. Well thank you. This is really interesting, and I want to underscore Undersecretary Chang's comment that I haven't heard this conversation in this manner, and it's really an important starting point, or continuing point, at least in the FERC policy context.

I'm hearing about two kinds of planning. One is kind of physical vulnerability planning, and then one is the more traditional electrical system planning that we have thought more about in the FERC context.

And at the beginning several of you have mentioned this, and at the beginning talked about the relationship between the two, or the lack therefore as well as any changes I think Miss Webb referred to changes on the system planning side that it's not just putting the right inputs in, but it's that some of those processes need to be changed.

So the first part of my question is can you the panelists who are interested speak to the appropriateness of the existing regional -- let's start with regional and we can go up to interregional, or down to local way that we do transmission system planning, and then I'll ask a question about the data we use after that.

MS. NUTTER: And the panelists if you would like to respond please raise your hand. Mr. Stenclik I see that your hand has been raised.

MR. STENCLIK: Sure. I'll take a first stab at this. I think there's a few things I'll touch on the system contacts. One is regardless, again regardless of climate change there's a lot that needs to be done on resource adequacy topics and the methodology given the change in the resource mix, and the reliance on the weather.

So as you can tell from a lot of my comments I've taken the approach of kind of a resource adequacy analysis perspective and how climate change interacts with that in terms of reliability. Obviously, reliability is very broad, so and my comments are stemming from a task force I lead with the energy systems integration group.

Specifically around how methodologies should be rethought around resource adequacy planning. A lot of that is you know certainly better accounting of the underlying weather, needing to evaluate a full year of the operation, not just our conventional peak load periods, so I think that's a really big takeaway that is also very applicable in the climate context.

Looking across an entire year is not just the historical you know peak risk periods, or peak load periods that are going to be the most challenging, but another thing that you brought up Commissioner Clements about the vulnerability planning and how those aren't linked together. I think you know I still view the resource adequacy, the probability assessment using the weather observations is very important and should continue.

We should incorporate a climate trend to that, but we also have to go one step further I think and just do a vulnerability assessment to say what -- to evaluate what if scenarios, you know what if a four day low wind and solar event were to occur on the system, does that impact system reliability?

So as opposed to the conventional approach of just doing the probabilistic inputs at the model and seeing what the expectation of reliability out of is kind going the inverse and saying you know evaluate a few what if scenarios explicitly, and if they have a material impact on reliability, then going back to the climate folks and the meteorological folks and saying is this plausible in the future?

Is it plausible for me to lost 30 percent of my gas fleet because temperatures dropped to X, or is it plausible for there to be a four day sustained low solar and wind output? Then you can almost assign a probability of that type of event occurring. I think a big takeaway for me after the Texas event in February is how do you ask me to do a resource adequacy analysis in Texas ahead of that?

There's no way I would have caught the magnitude of that event. And I think that's an important thing to step away from and say you know we have to go one step further than just conventional resource adequacy planning, and do these what if scenarios, and then work backwards to say what's the likelihood of that occurring.

MS. NUTTER: Thank you very much. Commissioner Clements, if you will work through the panelists who wish to respond if that's all right.

COMMISSIONER CLEMENTS: Great.

MS. NUTTER: Okay. So I believe we have several hands raised. I believe the next person to speak is Ms. Barton?

MS. BARTON: Thank you. So first and foremost I do want to say I agree with everything that Derek just said. Getting resource adequacy right, looking at it differently, looking at how resource adequacy can be bolstered by companies with generation at the other side of the scenes is really, really important for us to start to consider.

We also have to make sure that we're not throwing away the deterministic planning methodologies that we have in play right now. So we designed the system based on you know looking at it from a peak demand standpoint. We look at it by taking different assets out, and doing N Minus 1, Minus 1 type planning.

That's all well and good, but now what you're hearing is that we have to complement that, so we have to layer on probabilistic planning. By not looking at an endless host of scenarios, but a couple of scenarios, and I think it can be achieved when we take that downscaling of some of these climate views, and I will say this -- we'll need to be using the same one, or similar ones because what we don't want to do is have all of the different utilities out there, all of the different RTOs arguing about what's the right study that we should be using.

It's important for us to use the same study because then you're going to have at least similar views, similar analyses. As you know, how we actually get transmission for example constructive, is we have to go to our state regulators. We have to show determination of need.

If my determination of need is different a neighboring utilities determination of need, it just introduces unnecessary confusion and that's why I think that it's a fairly systematic methodology that we can use. I mean every utility can sit there and say you know given a particular downscaling scenario, what's going to happen to my assets?

And one example might be I've got a 100 mile line that's 70 years old. It's going to come down. What are the ramifications of that being out for an extended period of time because it would take me several months to restore.

You can answer it again at that utility level, and then you look at it from an RTO level, and again just looking to see how can we get some no regret solutions or no regret support at the seams, which really can be done is you say we want to have a certain minimum transfer capability so that resource adequacy we can lean on each other.

So for generation diversity we can lean on each other. For system reliability and resiliency we can lean on each other and that becomes the insurance model that Judy was talking about.

MS. NUTTER: Thank you so much. Miss Webb I believe you're next.

MS. WEBB: Yeah thank you. I agree with the previous two panelists in that we need to supplement the existing sort of planning approach, particularly the resource adequacy planning approach with this more climate specific form of planning.

And the Department of Energy has referred to that as climate resilience planning which includes a vulnerability component, looking at to the previous panelist's point, looking at how specific assets and operations will be impacted by specific climate variables.

And we do that using all of the things that we talked about, the downscale, the probabilistic models, but it needs to be a very sort of location specific, and asset specific analysis. And that needs to happen at the utility level. It can also happen at the system operator level that was mentioned earlier in the work that NYISO has done.

But at the RTO/ISO level, to inform those other planning processes, so that we have a better understanding of how these multiple climate impacts which could occur simultaneously and affect multiple parts of the system, where those risks are and how they actually manifest.

So it's really sort of supplementing those existing planning processes with a more specific planning process that some utilities and some system operators have staff to do, but certainly relatively few have done that sort of analysis. And a lot of the utilities and system operators that have done that sort of analysis -- the analysis has been very limited, or has had real flaws.

For example, relying on historic weather data, which as we've talked about a lot isn't a good indicator of future conditions. Only looking at one climate, or two climate variables and so missing those sort of compounding cascading impacts that we talked about earlier.

And so it needs to be a very comprehensive review, a specific review, and relying on that forward looking localized data.

MS. NUTTER: Thank you very much. Undersecretary Chang would you like to go next?

MS. CHANG: Yeah. I couldn't articulate it better than the previous two panelists. I'll just echo everything they've said, but I want to bring it back to the you know Commissioner your question about at the regional level. I do think there's a significant role that those regions that have an RTO/ISO could play. For example, first of all just having this dialogue already shows that we're planning you know proactively.

We're thinking about planning in a proactive way. I can't emphasize the importance of that. I think we have to plan in a proactive way. I don't think New England has done that yet, so we do need to look at scenarios, even without climate risks, we need to take a scenario-based proactive way to plan the system, whether it's resource adequacy or transmission planning, and I do agree with previous panelists it will be best if we can use consistent set of data, internally consistent set of data, so that we're not using you know a summer in a different year with a different winter and the hydro is not consistent with the solar and the wind.

I think we need all of that in a consistent manner and ideally we would love to be able to do that on a national level, and then each region RTO/ISOs can use that data at the regional stage, or the regional granularity.

And then I think in addition to scenario-based which is the deterministic approach, we also do need to think about the tail end of that distribution, or sort of that 1 in 10, 1 in 100 risk, and really ask ourselves how -- this is not just like billed to that 100, 1 in 10 or 1 in 100, but really ask ourselves the potential costs of those extreme events and compare to what kind of investments we might need to prevent or at least mitigate, those extreme events.

I don't think we do that today. I don't think we do that adequately. I think we do need to think about those extreme events, and maybe there are some insurance products which means really certain smaller investments, or investments in either grid or storage, or interregional connections that will immediately help mitigate severe weather dependent events in the future.

So I think it's a combination of this scenario deterministic approach, but also think about the outliers, the outer edges of those risks and buy our insurance now so that we don't experience those ERCOT-like experiences every two to three years. I mean with the climate forecast I think these severe events will occur more and more frequently. Thank you.

MS. NUTTER: Thank you very much. Miss Hogle I believe you're next.

MS. HOGLE: Yeah I agree with what everyone else has said. I think the only thing I would just add here is on the transmission side, you know obviously resource planning and transmission are inextricably linked, and so you know kind of the typical outlook or planning process of 10 years could be constraining.

And you know at least for us in California CAISO has recently begun an initiative to look at a 20 year transmission outlook that you know can help inform and facilitate consideration of like larger lead time projects that can accommodate investments and support greater system diversity and resilience in a high penetration renewable future as well as have the climate related benefits, getting back to the insurance point that my colleagues have raised.

MS. NUTTER: Thank you very much. Miss Barton your hand is still raised. Do you wish to speak again?

Miss Barton?

MS. BARTON: Okay sorry.

MS. NUTTER: Commissioner Clements did you have any follow-up questions you wish to ask?

COMMISSIONER CLEMENTS: Yes. I have one follow-up and then I'll save in case others want to ask questions. There was a lot of good input there. Miss Barton you mentioned interregional transmission, the availability to lean on your neighbors.

And I'm wondering if you can say a little bit more about how interregional planning frameworks can be adjusted to better aim at improving system reliability and resilience to extreme weather, and I think the most recent example that people keep talking about is the fact that in the worst part of the Texas mid-central extreme cold in February, MISO was importing 13,000 megawatts of resources, of supply and also exporting another 3 or 5, I don't remember the exact number, the SPP and that was an important part of their reliability approach.

In particular, you mentioned interregional transfer capability and I'm wondering if you could speak to that you know, potential reliability standards related to that, or other thinking around ensuring sufficient transfer capability across regions.

MS. BARTON: Sure. I mean one of the ways that you can do it is you can sit there and say that you want to from a resource adequacy standpoint, be able to rely on X percent from a neighboring region. I mean in the end you would actually be building less you would be saving more money.

If we actually did lean on each other more. We actually have the utilities who are on both sides of that border, both we have two in SPP and one in ERCOT, Texas, and if we had a better ability within Texas to import generation from SPP and other regions, we would have been in a better situation. We would not have been that dire.

We saw, if you really look at a snapshot in time what was PJM's generation portfolio looking like, everything was running as normal. MISO was able to help SPP a bit, and SPP's wind production was actually outperforming what they expected it to be. But it's really just getting at the fact that we have more variable resources.

When you have more variable resources you have less control. It means you need to have something else in your quiver to be able to address that. And having greater diversity of renewable generation would help that, and that's how you do it, is basically increasing those -- strengthening those seams.

Because right now you know I've been in this industry for decades upon decades it seems. And I've been talking a lot about transmission planning, and I've been talking a lot about interregional planning, and yet there really has never been interregional planning.

And that's something that with the changing needs of the system we have to fundamentally change that because customers and community's expectations of the grid are changing. We can't afford what happened in ERCOT, Texas to ever happen again. We really have to sit there and figure out what are those no regret solutions, and I think that that's one of them.

COMMISSIONER CLEMENTS: And do you have a distinction in between how those teams worked in an RTO to RTO function versus an RTO to non-RTO setting?

MS. BARTON: I really haven't, but you can really just implement it from you know I think if FERC were to desire to issue an order you could do it a couple of different ways right? You could basically sit there and say whether it's an RTO or a non-RTO utility for those you know two to get together, and to determine what is the appropriate transfer capability between those regions.

And then certainly it does get complicated, it's a little bit easier when we're talking RTO to RTO, but at least what I've found in the past is if there's a timeframe that folks need to get back, if there's a solution set that needs to be solved for, then you'll set some movement there.

But I think absent FERC pushing on that, I think it won't happen to be honest.

COMMISSIONER CLEMENTS: Thank you. Thanks Louise.

MS. NUTTER: Thanks very much and is there anyone else who would like to speak on this topic? Please raise your hand if you would like to do so. Okay. Seeing none I will turn it over to my colleague Ena who will introduce the next question.

MS. CHANG: Actually I just want to add one note to what Miss Barton just said. It just amplifies the same thing really. It is extremely important for interregional planning and actual building interconnectors, even for the regions that are already interconnected -- ERCOT to the rest of the country.

But while we in Massachusetts looked at the decarbonization pathways in every future scenario we need more interconnections with our neighbors, and that's -- it's just a capture of that diverse, even if nothing else we want to be able to capture that diverse resource portfolio that Ms. Barton talked about. Thank you.

MS. NUTTER: Thank you very much. Mr. Stenclik do you also wish to respond?

MR. STENCLIK: Yeah I have one last thing to add on the transmission. It's really thinking about transmission more as a reliability resource or as a capacity resource. I think traditional transmission planning, we often fall into the trough of just evaluating a transmission project based on the production cost benefits or to relieve the congestion, and we fall short of really looking at other value stacking, predominantly probably the largest one there being the ability to look at transmission as a capacity resource in bringing in the reliability benefits.

So I think very similar to how we've all become accustomed to value stacking storage across a lot of different services, you can take that same approach and people do take that same approach on transmission. I think really valuable to look at transmission not just as a way to lower operating costs which it does, but and access renewables, but also as a capacity resource.

And in some of that is building new lines. Some of it is just the institutional friction between these different authorities. I completely understand each utility and each ISO wants to make sure they can maintain reliability kind of by themselves, or domestically.

But using the reliance of neighboring systems and making sure that when you do the resource adequacy analysis you do a full system, or full interregional analysis that doesn't simplify the assumption of okay, how much can we lean on our neighbors, but look at the neighboring utilities and neighboring ISOs in the same probabilistic manner that you're evaluating your own system with. I think that's critical as well.

MS. NUTTER: Thank you very much. Was there anyone else who wishes to speak on this topic? I don't see any additional hands raised, so Ena if you would like to?

MR AGBEDIA: Sure thanks Louise. So the next question is How should climate vulnerability assessments be translated into actions that promote least-cost outcomes for consumers? What are specific steps and considerations that lead from identification of a climate vulnerability to least cost solution that address that vulnerability? I'll direct this question to Miss DesRoches.

MS. DESROCHES: Great thanks. So clearly you have to look at the cost of multiple solutions and I think this has been brought up a few times. That's important as we look at the wide array of what the client projections might be saying mid-century and in particular, in the end of century.

To just put that in context in New York City sea level rise, if you look at the full spectrum of the RCP's goes from about 10 inches to 72 inches. That's a pretty big range. And so you know as we look at what the costs will be, what are we buying down? How much risk are we buying down and how conservative do we need to be for each set of solutions -- both at the asset level, but also at the systems level.

I think this can't be decoupled from the investments we're going to make for decarbonization right? So you know we can very simply think everything on the coastline needs to be elevated or moved, or we can think about when we move to a system that's powered by offshore winds, solar and storage, how do we locate and build out over time those assets to actually be more resilient to climate change? It needs to be thought of at the same time, and what's unfortunately what ends up happening is you have some of the clean energy movement and it's fantastic and we're moving as aggressively as possible, but we aren't at the same time integrating those future weather conditions and that resiliency that needs to happen.

So you know I would say that as we're costing and looking at investments in the clean energy, we have to couple those with the resiliency investments, and really look at what that range of investments is going to cost, both to integrate the clean energy into the existing system, and improve that system while we're doing it.

And to what level? So that makes it complicated, but then can that be upgraded over time? Do we have to build today for 2100 projections that are at the very high end, or is there a way to do sort of interim level adaptation that are flexible enough, or technologies that we assume will come that we can install in the second half of the century to make those assets stronger.

I don't have easy examples of how to do that, but if we don't start thinking about it that way today, we're going to transition the energy system in a renewable system without having properly accounted for the cost of the resiliency investments that need to happen.

MS. NUTTER: Thank you very much. Miss Webb I believe you're next.

MS. WEBB: Yeah thank you. I fully agree with everything that was just said. We should be absolutely looking for opportunities to build in resilience at the outset to avoid costly retrofits and hardening in the future, and also looking at sort of flexible resilience measures that are adaptable in the future.

I would just add a couple of points which I think sort of build on that and resonate with that. One is that the evaluation of resilience measures really needs to take into account the full suite of those measures.

Often when we focus on sort of traditional or legacy approaches like investments in the capacity or asset hardening, but there's a whole load of other things that can be done as was said building in that resilience up front, looking at customer oriented, or customer focused resilience measures, the distributed storage, demand response et cetera.

And when we're comparing those different measures looking across those different measures we need to take into account their relative climate benefits and costs, so evaluating those resilience measures through really a climate change lens. You know it's perhaps an obvious point, but it's worth restating that entities really should not be responding to the risks posed by climate change by engaging in activities that themselves contribute to climate change.

So we want to avoid these sorts of now-adapted outcomes, now adaptation outcomes where responding to the symptom of a particular risk in a way that exacerbates its underlying cause. So when we're thinking about resilience measures we should be thinking about them in terms of their contribution to greenhouse gas emissions, those that increase greenhouse gas emissions really shouldn't be pursued, they're really not climate resilience measures.

And related to that I would just say that I think we need to explore new tools for comparing and evaluating the resilience measures. We tend to rely very heavily on cost benefit analysis which can be used, but has some difficulties in evaluating resilience measures specifically.

It can be difficult to identify and accurately quantify some of the benefits of those measures in part because they depend on future outcomes, future climate outcomes which aren't 100 percent certain.

So again that doesn't mean that entities can't or shouldn't respond to the risks of climate change, or shouldn't be taking measures to improve climate resilience, but it does mean that we need to think about new approaches for evaluating those different measures.

So there's been various proposals put forward. One that's often referred to as the robust decision-making, or RDM framework, which evaluates resilience investments, or resilience measures under a range of possible future scenarios to look at what perform best across a range of outcomes. Also those mentioned earlier of sort of incorporating flexible pathways where we take these sort of no or low regrets measures now and then look at other measures in the future when we have greater certainty about what future impacts will be.

But there really needs to be this wide-ranging review of all of the available options through that climate change lens, and with that flexibility built in thanks.

MS. NUTTER: Thank you very much. I think Miss Hogle you're next.

MS. HOGLE: Thanks. I just wanted to provide an example of you know utilizing new tools and ways to evaluate these investments, but before I do so I just want to say you know the question in and of itself in some ways has a bit of a false premise because we know that you know planning and making these investments early is less expensive for our customers, than having the event occur and then having to rebuild and respond after the fact.

We heard about the trillion dollars of investment that we've had to make in climate driven events at the beginning part of this conference. But that being said, I completely agree and I can provide an example where you know in California in our service territory, especially in the remote areas that we serve that are very prone to wildfires, we've been able to evaluate you know the costs of maintaining let's say a line that you know could be a couple miles long, but is serving just a few customers on the other end of it, and you know looking at what are the insurance costs, what are the costs associated with you know maintaining that line and doing the budget clearances, the labor costs and everything else.

And we've actually found that it's a better option, it's more resilient -- climate resilient, because you reduce the risk of wildfires by removing that line, and it penciled out from a cost perspective to just serve those four or five customers with the remote grid that has a combination of you know solar and battery and backup natural gas or diesel when necessary.

So I think that you can kind of use all the tools available like definitely do a comprehensive cost benefit analysis of these investments and then find that you know at least in this case serving these customers in an entirely different way than we typically would was the right thing to do, and we plan to do more of those.

So I just wanted to provide that example to follow-up on my colleague's comments. Thanks.

MS. NUTTER: Thank you very much. Mr. Stenclik I believe you're next.

MR. STENCLIK: Yeah thanks. I think I'll come at this again not surprisingly from our resource adequacy angle. And really I've talked a lot today about how methods need to change with increased, or with the changing resource mix and climate change, but so do the metrics, and right now in most places across North America we rely on a 1 day in 10 year loss of load expectation as the primary, or the not often cases the sole resource adequacy or reliability metric, and that's how we design our capacity markets.

That's how we design our primary serve margin, and fundamentally how we procure resources to meet our reliability requirements. And fundamentally with the changing resource mix with climate change, a loss of load expectation is not going to cut it in the future because it only measures the frequency of events occurring, it does not measure the size or magnitude, or duration of the events.

And so we need to go further with our resource adequacy metrics, metrics like expected unserved energy, or EUE captures some of that. So it's a step in the right direction. We need to have metrics that can capture you know when we have a shortfall event, or when a shortfall event is likely. How big is it? How long does it last for? When does it occur?

Really drilling into those metrics is critical because that allows the system planners to right size the mitigation right? It's to make sure that the mitigation that's selected fits the need, and we're not just over-procuring resources just to provide reliability all hours of the year when in fact it's you know it could be short duration, it could be long duration.

We really need to understand what the driving factor is to make sure for the ratepayer, the consumer we're fitting the mitigation to that need.

And then another thing that came up previously I think Judy mentioned it, is all of our resource adequacy metrics today really focus on expected values, or just the average value. We rarely look at the tail end risk.

And really making sure that we go beyond just looking at average values, or average risk assessments, and looking at a full distribution of potential outcomes so that we can take into account how bad with that worst case about being and is it worth addressing some of the larger outlier events, especially if there's a low cost solution for them.

MS. NUTTER: Thank you very much. And I believe Miss Barton is next, and then I believe we have another question from Commissioner Clements.

MS. BARTON: And I do think that this is a very difficult question to answer. You know I think when we look at least cost outcomes we have to do a couple of things. We have to start with where this discussion started, which is what is the cost of these outages? What is the cost of climate change? And how do we then mitigate that and what is the cost associated with that mitigation?

So for me it's two camps. There's the insurance related no regret changes that we can make. So in my view that is making sure that our black start generation is well secured, that our black start crank past our redundant. For example, it's worth asking probably folks in the industry what is your black start path? And how old are those assets?

What might happen if you were to have you know a severe event that's going on in the system? You want to make sure that you have that ability to restart the grid if you ever need it. We've never been as close quite frankly, to losing an interconnect as we were with Texas just a few short months ago, and despite the weatherization you know, a lot of the things that the state is actually working on. That still remains a significant risk.

And making sure that if the worst happens, that we can actually restart the grid in a timely fashion. That's important. As Derek mentioned on the resource adequacy again. That's just a no regrets. Having that insurance mechanism by which we're leaning on other regions, these are quick and easy hits that we can move forward on that's going to give us a little bit more time to tackle some of the complexities associated with really doing that deep dive that's necessary to get this right.

When you take a look at a downscale of what happens, this is going to take some time. It's going to be complicated, and we need to sit there and figure out how do we simplify it, how do we make it less complicated? How do we make it less costly?

Which means we're going to need to do a lot of studies, and that's why the no regrets solutions allow us more time. And while this isn't a planning comment, one of the other things that you can do, and I think it falls into the you know insurance category, is you maintain a controllable amount of generation that's there in reserve should you need it.

I think the biggest challenge we're going to have with this transition is just that very fast move to all variable resources. If you have the ability to bring on some controllable resources again on the emergency situation, only to deal with preventing these kinds of things I think you can make sure it's a lot less costly than it otherwise would be.

MS. NUTTER: Thank you very much. Commissioner Clements would you like to ask a final question?

COMMISSIONER CLEMENTS: Thanks Louise. I know we're running out of time. Mr. Stenclik just a follow-up on your last comment. Appreciating that there's a broad spectrum of types of overlapping resource adequacy authority in states, and FERC, and the regions. How do you think FERC should start getting at these issues you're identifying in terms of insuring improved planning relative to these evolving extreme weather risks?

MR. STENCLIK: Yeah I guess the first thing is just to start pushing forward best practices and ways and methods that should be included. I think one of the approaches that we're taking with redefining resource adequacy is setting up a set of first principles that we're then trying to disseminate, and when we work with stakeholders in different regions, different ISOs, different utilities, it is trying to develop a framework recognizing that each region is going to have its own regulatory structure, it's own resource mix, its own unique approach that they need to take for resource adequacy, but what are some of the first principles that apply really across the board and set up the best practices that could be applied.

I think on the metric side there's ways to well you know it's fuzzy who has jurisdiction and to saying what the reliability criteria should be. I think a low-hanging fruit is just to make sure that when resource adequacy results are shared that all the metrics are provided.

You don't necessarily have to change the criteria, but you can at least report the data more holistically, so you're not just showing an expected value loss of load number, you're showing a broad suite of metrics. Even though one of them might be a criteria, you can still at least report some of that.

And I think on the regional coordination maybe that's an opportunity for FERC as well to really look at regional coordination between different jurisdictions on how they can make consistent assumptions on how to rely on one another for reliability and resource adequacy.

COMMISSIONER CLEMENTS: Thank you and we're out of time. I appreciate it.

MS. NUTTER: Miss Chang your hand is raised. Did you have something?

MS. CHANG: Yeah I just want to say one thing in a very simple way if there's something that FERC can do I think is to in addition to the metrics, I think just saying to each region for utilities for the non-RTO regions, say you know pay attention to climate related risks, which we haven't even had in this industry, and then if we you know, if we could take that one step further to say you know I looked at this before a year ago.

Italy is doing this, which is have them come up with a plan, whether it's resource adequacy, or transmission planning, come up with a plan that incorporates the best climate data that you can get your hands on. And maybe the first time around is not perfect, but I think having FERC to say you know come up with a plan that incorporates climate data is a huge step forward that we haven't had in this industry.

And I think that would be an important starting point.

MS. NUTTER: Thank you very much. And thank you everyone for a great discussion today. I'm going to pass this to my colleague Ena to close our panel.

MR. AGBEDIA: Thanks Louise. Thank you very much everyone for that discussion. We've reached the end of our time for this panel. So I'll conclude by thanking our panelists again. We appreciate your participation. We will now take a 20 minute break and we'll reconvene at 3:45 p.m. Panel 1 speakers you may sign out of the Webex, and if you would like to continue the conference you can use the public web link that was sent to you, or you can visit at ferc.gov.

Panel 2 panelists please stay with us over the break and Commissioners stay signed into the Webex for the break as well. Please mute your microphones and turn off your cameras until we resume. Thank you.

(Break)

Panel 2: Best Practices for Long-Term Planning Assessing and Mitigating the Risk of Climate Change and Extreme Weather Events

MR. VANDERBERG: Thank you Rahim and thank you everybody. Welcome back. I am Eric Vanderberg. I am the Deputy Director of the Office of Energy Policy and Innovation at FERC. Along with me today I have my co-moderator Lena -- from the Office of General Counsel and we will be moderating our second panel.

So this second panel will explore how existing planning processes address climate change and extreme weather events and possible improvements to those planning processes. This panel will engage in a broad ranging discussion of relevant best practices throughout the industry for assessing the risk posed by climate change and extreme weather and developing cost effective mitigation.

We will be foregoing opening remarks for this panel, and we're going to move directly into a question and answer session. Following this panel we will adjourn for the day and resume tomorrow afternoon. So with that I'd like to start by introducing our panel 2 panelists.

First we have Judith Curry. She is President of the Climate Forecast Applications Network. Joining us today we also have Neal Millar, Vice President, Transmission Planning and Infrastructure Development at the California ISO.

Mark Lauby, Senior Vice President and Chief Engineer at the North American Electric Reliability Corporation or NERC.

We also have Devin Hartman, Director of Energy and Environmental Policy at the R Street Institute. Also have Alison Silverstein, Independent Consultant with Alison Silverstein Consulting; Richard Tabors, President, Tabors Caramanis Rudkevich and last but not least we have Frederick Heinle who is the Assistant People's Counsel, Office of the People's Counsel for the District of Columbia.

Welcome to this esteemed set of panelists. We really appreciate you joining us today. Before we get into our question and answer session I'd like to remind everybody again to refrain from discussion of any pending contested proceedings. If anyone does engage in those kinds of discussion, my colleague, Michael Haddad from the Office of General Counsel will interrupt the discussion with a gentle reminder to avoid that topic.

So we'll now begin the question and answer. Panelists who would like to answer a question please use the Webex raise hand function. Alternatively, if you're having issues with the raise hand function please turn on our microphone and indicate that you would like to respond.

I will call on panelists that indicate they would like to answer in turn. Once I call on you please turn on your microphone and respond to the question. Once you've completed your answer please turn off your microphone, and just a reminder to also lower your virtual hand in Webex.

With those preliminaries out of the way we can go ahead and get started and first of all I would just like to start by saying thank you again to everybody to help organize this panel and all of our panelists today. We have a really excellent group here and so I want to go ahead and dive right in.

Where I'd like to dive in is a little bit where the last panel left off. I thought there was a lot of really good discussion on the last panel about you know the distinction between some of the climate change impacts like sea level rise, rising temperatures, and extreme weather events, you know the things in the former category, those are things that will occur more gradually over time.

Things of the latter category, particularly at the outer edges of those risk distributions, those 1 and 10 year events, those 1 in 20 years events, those 1 in 30 year events, can really have devastating effects, so in lieu of opening statements what I would like to do is start with a question, and I'd like to hear from all of our panelists, and that question is are current approaches to long-term resource adequacy and transmission planning adequate to address these type of tail risks such as extreme weather events?

Yes or no, and if not in your opinion what needs to change about the way the industry assesses and mitigates risks. So I'd like to go ahead and start with Judith.

MS. CURRY: Thank you. I appreciate the opportunity to participate in this conference. As President of climate (audio glitch) -- to help them anticipate and respond to extreme weather events. On time scales of days to weeks we provide probabilistic forecasts of extreme events. These include heat and cold outbreaks, hurricanes, wildfire risk and severe convective weather.

(Audio glitch) we provide regional scenarios of future extreme weather events including event frequency and the severity of the worst case. These scenarios are based on natural multi-decadal climate variability, as well as manmade global warming. I don't rely on (audio glitch) since the climate models provide a range of weather outcomes that is too narrow.

To help avoid big surprises we provide catalogues of historical extreme weather events impacting the region. If it's happened before it can happen again. (audio glitch) and I'll answer the question how bad could it get -- in other words what if scenarios.

It's too expensive to harden the infrastructure and maintain reserve capacity for any conceivable extreme weather event. The question then becomes how much resiliency can you afford. The (audio glitch) the expectations used in designing the infrastructure. Too often the response is to passively watch a cascading disaster unfold, and then clean up afterwards.

The impact of an extreme weather event can be mitigated to some extent by making better operational decisions (audio glitch). Tactical adaption strategies can be developed from considering plausible worst case scenarios associated with that particular type of event.

Response protocols are developed, and then deployed operationally in a (audio glitch). Such strategies support robust decision-making and can result in better outcomes with less damage and more rapid restoration of services. Here's an example. Since 2013 my company CFAN has been (audio glitch). -- impacted by hurricanes. Reconstructive landfalling winds from historical hurricanes are used to draw their outage models to produce a range of possible outage scenarios.

A catalogue of synthetic worst-case storms have additional data (audio glitch) -- for assessing their response strategies. Risk management begins 7 days prior to a possible landfall, CFAN provides extended range probabilistic forecasts of tropical cyclone threats (audio glitch) -- models. A catalogue of historical and synthetic worst case storms is used to assess the worst case possibility for the pending landfall.

Based on CFAN's ensemble forecast of landfall winds, outage models are (audio glitch). Estimates of manpower requirements are made so that mutual aid repair crews in local repair units can be in place several days before the actual landfall.

This general approach of developing technical adaptation strategies can be (audio glitch) - that reduced damage to infrastructure and will quickly restore service. Thank you.

MR. VANDERBERG: Thank you Judith. Let's go to Neal next followed by Mark.

MR. MILLAR: Thank you Eric. I would say at the

ISO we see the current approaches create the opportunity to consider the broader range of conditions that need to be assessed, but not necessarily require them. Following on the standards that are employed for transmission planning, the study of extreme events is something that's expected to be conducted considering the local conditions and the issues facing that particular system, and the people operating that system, but there aren't hard and fast criteria as to when someone should mitigate and to what extent.

And so we see the criteria themselves as creating the framework, but then the question is are people taking it as far as they need to, and considering how far some of these issues should be pursued. And there that's where I think the bulk system issues combined with the resource planning need to be taken into account, and that we can do more on these conditions, but I'll look forward to talking about the details as we go through the conversation, so thank you.

MR. VANDERBERG: Thank you Neal. We've got Mark next followed by Devin then Alison.

MR. LAUBY: Thank you Eric. And I'm also delighted to join this panel today, and to think about where we've come from. And in the past when we calculate capacity measures the 1 event in 10 it was based on a number of assumptions, most importantly, that capacity equaled energy plus reliability services, plus flexibility of ramping.

So if we had the capacity we had a number of other things available to us. That's one. The other is of course the conditions. We can't be looking at the last 30 years and projecting those for the next 10 or 5. We have to start thinking a little bit more outside the box because it's no longer what's possible, but what's plausible.

So we can start thinking a little bit more around not only the capacity needs, but the energy needs. And remember that it's a basis of a lot of these adequacy analysis. It was around independence. Independent forced outages due to random failures in plants. And sometimes it would take -- or units. Sometimes you would take a plant out just to be really excruciating on the system.

But now we're talking about common conditions, and we're talking about a resource mix that is now affected more around the extreme weather. And when we talk about extreme weather we're talking about something a little bit different here too. Extreme weather was hurricanes, tornadoes, the ratios you know severe blizzard.

Now we're talking about extended cold weather, extended hot weather, weather, wind droughts, solar droughts, and we have to build those into our framework, and of course we don't have a lot of experience looking back, so we have to see what's possible going forward so we build a system that not only provides the energy along with the capacity energy and ramping and reliability of services, but then ensures that they are there during the more severe long duration events.

So with that I'll be happy to pass it onto my colleagues. Thank you.

MR. VANDERBERG: All right. Thank you Mark. Devin then Alison.

MR. HARTMAN: Thank you Eric and thanks to you and the rest of the Commission for having me today and for addressing this important topic. It's 1,000 foot level that I will start off with emphasizing is that you know the top of our panel looking at long-term citing best practices.

I really emphasize that there's a big gap between existing planning processes and best planning processes under static climate conditions, and then I would look at the gap between the static best planning practices, and where we are under global climate change.

And I think the existing deficiencies that we see in many ways from which climate risks in the existing reliability policy, and we look at the ways that climate change manifests itself in that risk profile. We really need to recognize that as a previous speaker said there's a lot of work we can do on just a no regret approach. And I think that's really important to emphasize because I think climate risks largely exacerbate a lot of the existing risk factors that this industry ostensibly already incorporates to some degree.

But as the magnitude and the likelihood of some of these events increases over time, any deficiencies that we already have in our reliability risk management framework are going to be further exacerbated. And so to your point on specifically on resource adequacy transmission planning overall, I really emphasize that as we think about tail risk and how these constructs incorporate tail risk, that we think about a few elements.

So one thing is we do recognize that this industry has always relied on engineering characteristics, and we've always you know pushed the need to make sure that this economic criteria that is getting better infused into that ecosystem, and that those are reliability institutions, and are more market-based institutions and processes are seeking up better.

And then next when we think about this conversation about should we be thinking about expected outcomes and drivers of central tendency et cetera, as opposed to you know indicators of reliability paradigm adjustments as we compare that to the incorporation of tail risk event, I think that we need to make sure that we emphasize that we can distinguish between risk and uncertainty.

So a lot of climate risk will actually manifest itself in things that are reasonably known probabilities. I think that we can assign probabilities to, and that we can codify the consequences on. And thus, when we do a better job with economic criteria, we can better understand the consequences and develop expected values right, which is the basis for cost benefit analysis and conventional risk assessment.

Whereas, when we get into uncertainty analysis, we get to the spaces where we have a lot more unknowns and perhaps we can't even assign a probability. That's where we need to start doing and employing tools like break even analysis and other tools to at least say hey, if we're going to construct scenarios about things, about like correlated outages and how they're affected by perhaps multiple climate risk vectors that could be worsening in the future, that we at least build in more transparent single modes and how they manage, and multiple risk streams.

And then we at least can evaluate the avoided damages, or the reliability benefits of reforming policy to address those. Thank you.

MR. VANDERBERG: Thank you Devin. Let's go to Alison followed by Richard.

MS. SILVERSTEIN: Thank you and good afternoon.

Thanks for having me in the panel. I agree with everyone else that current planning methods are inadequate. This topic -- our panelists focus on long-term planning, but to be frank it's not clear that short-term planning methods are significantly better than long-term planning methods because they both use a lot of the same premises.

We are not using enough creativity and imagination about the breadth of the threats and consequences. A lot of what we are looking at in terms of -- or what we should be looking at in terms of threats and consequences as others said, have compound and synergistic effects.

But beyond that I think we are in -- it is very difficult for me to see how to realistically put believable credible probabilities on most of this. So I think we need to stop pretending that we can do sort of deep, deeply credible probabilistic weighted scenarios, and calculated meaningful expected values, and just start looking for where are the boundaries of all the scary things that might happen that we should be preparing for.

Second, we need to be a lot more focused on consequences, not just causes. In many cases so many of the things that could go wrong all have the same consequences, and most of them are dreadful -- for the system, for customers, and for our economy.

So that says to me that we need to put a lot more focus on how do we mitigate, and as the prior panel discussed insure against these common consequences, and put a lot more emphasis on protection and resilience, rather than attempting to prevent every potential thing that could go wrong.

Some of the most -- those what they were calling no regrets or insurance measures. If you look at them from a consequence perspective and ask how do I find mitigations that are going to work every single day, rather than only pay off against a single kind of harm. Those include transmission, storage, demand response, black start, and frankly energy efficiency, which is probably one of the most effective ways to protect customers against all the stuff that could go wrong.

And particularly, building on the load, protect improvements, air-conditioning and heat, because inefficient heating and inefficient air-conditioners are what contribute to some of the most trying things and times that go wrong on customer, in terms of causing the grid to have operational problems.

And last I concur with many of the past panelists that when we talk about cost benefit analysis we far too often talk about and assume that what matters is the cost of the measures that we are considering taking, rather than comparing not just those measures against each other, but more critically what are the consequences and costs to us if we don't take these measures?

What could go wrong? And how do the costs of more transmission, or more energy efficiency, or better demand response -- how big or small are those costs, and how often will they work and help us compared to the very significant costs of the kinds of events that Texas just suffered because we hadn't taken enough of those protective measures, thank you.

MR. VANDERBERG: Thank you Alison. Let's go to Richard next followed by Eric. Richard if you're speaking you're on mute.

MR. TABORS: Thank you sir. So I'll start again. I am my coauthors and co-conspirators Paul -- thank you for the opportunity of participating on this panel. Taking a heavy look at your question I think the analytic methodologies and models in utility planning today can only be described as woefully and grossly inadequate.

Our resource adequacy metrics and planning methods systematically understate the probability, the depth, and economic health and safety costs of high impact events, and significantly increased demand or reduced reduction in the output of multiple resources.

So there's a lot going on, and I think that the fact that the industry still references an engineering driven reliability standard of 1 day in 10 years is somewhat close to unbelievable. That standard of LOLE doesn't consider the economic consequences of service interruptions, the fact -- and that fact is compounded by the assumption of unit outage independence, and a failure really to reflect weather trends.

Understanding the probability of common mode events is really the kind of the critical variable in all of this. We focus on the fact that weather is probabilistic in nature, so as a result we need probabilistic approaches to deal with it. We should adopt some probabilistic thinking to our demand forecast which is also weather driven, to intermittent resource forecasts, generation resource adequacy, and quite honestly transmission adequacy as well.

For example, on this one we've written about in the days proceeding the Texas event, it was well understood and recognized by anybody who really was looking at probability distributions that there was at least a 10 percent chance that temperatures would be fully 30 degrees below normal in Texas.

The result is that from my perspective on kind of answering your question, we have to really understand that there are probability distributions out there that we're simply not paying attention to and that fit nicely into the mindset of the utility industry, but we've got to get them into that mindset, not kind of ignore the fact that we know a lot more and are able to do a lot more analysis now, than has been the case in the past, so I'll stop thank you.

MR. VANDERBERG: Thank you Richard. And then let's go to Eric, last but not least.

MR. HEINLE: Thank you Eric can you hear me?

MR. VANDERBERG: Yes we can.

MR. HEINLE: Great and thank you, and thank you. It's been a delight to be part of this panel with such a distinguished group of panelists. I want to go to something that you just said, which is I think it's a really critical question. How much resiliency can you afford?

As a ratepayer advocate for ratepayers in the District of Columbia, I want to make clear that when we look at costs and resilience of the grid, we have to understand that resilience efforts that are not affordable do not make the grid more resilient. In fact they simply do not serve ratepayers interests.

And that's the goal of all to make sure that we are able to serve ratepayers 24/7, 365. So these efforts that are cost prohibitive really don't solve our issue. I'm here to tell you that consumers want to be part of the solution. And that's why I'm so thankful to be included in this panel.

Because consumers want a seat at the table. We want to understand, and we want to work with you on understanding how we do the analysis, looking at the information, look at the data, look at the popular six scenarios.

And consumers have an active role to play too, whether and I think something good Alison hit upon. Whether it's through issues like demand response, distributed energy resources, energy efficiency, these are all ways that consumers can play an active role in helping the resilience needs of the grid, and helping assure that we do get to a much more resilient grid, which frankly, as the last one that was shown we are not.

It's also important that there's an accountability level that when we look at different programs for you know whether it's an analysis of extreme weather events, whether it's incentives to address those events and tail end events, that there is a recognition that again these programs need to have a real benefit for consumers and -- the costs.

And then as I look forward to working with this group and talking at this conversation about ways that we can make the grid more resilient, that we can address the extreme weather events but do so in an affordable way.

MR. VANDERBERG: Very good thank you Eric. I appreciate it. A lot of good comments to get us started. Hard to pick where to start first but what I'm going to do is start off with a session of something that's come up a couple of times here and in the prior panel which is capacity.

A couple of panelists have mentioned you know the importance of thinking in a new way about common mode outages, changes in the resource mix, and then you layer on top of that you know the impacts of extreme weather events having you know common impacts across really large areas. So what I wanted to tee up was current resource adequacy approaches -- a number of people mentioned the reliable on the 1 in 10 year standard.

Do we need changes to those approaches to take a different tact in the way we look at it, the meet changes, and the way we think about the metrics and the way that we procure capacity, so we are getting the most value for consumers?

I see Alison's hand up. Alison's hand went up first so let's start with her and then Eric's was second.

MS. SILVERSTEIN: All those years of playing hit the button faster paying off thank you. Yes 1 in 10 is completely outmoded, and it's generation centric and ignores all of the other capabilities out there including demand response, including the fact that we can actually enlist customers to control their demand and manage it in better ways, and it ignores a lot of the other capabilities out there.

And the fact that the grid is much more energy dominant and stochastic than it used to be, instead of just turning a dial and controlling a power plant, or multiple power plants. So let's be super clear, and 1 in 10 is about capacity mostly, and not much else.

The ERCOT event and others have demonstrated that a lot of the things that go wrong on the grid are due to energy failures. We have lots of iron on the ground, it just isn't working. For a variety of issues that have nothing to do with the virtue of having iron on the ground. And 1 in 10 isn't going to fix that in any way.

The other problem with 1 in 10 is again it's all on the generation side, and since this is about the balancing of supply and demand, it ignores that it's often more cost-effective to improve demand than it is to just fix supply thank you.

MR. VANDERBERG: Thank you Alison, let's go with Eric and then Devin.

MR. HEINLE: So first off I would echo everything Alison said about the importance of balancing supply and demand and look at the supply, from looking at the consumer side, what can consumers do to programs like demand response and energy efficiency to meet the capacity?

But it's important that when consumers do that that when RTOs and utilities look at modeling for capacity they take into account the value of those inputs, the value demand response, the value of distributed energy resources. Make sure that they are accounted for when we consider you know what capacity we have on the grid, and I think you know, making sure that they're incentivized properly.

We talk a lot about for generation, but we also need to make sure we're getting the antennas right on the demand side as well. And on the load side as well. You know Order 2222 maximum opportunity I think to build on some of that with distributed energy resources. And again making sure that they are fully accounted for on the load side of the grid.

And then finally I think you know when we look at from a supply side, looking at constructs like effective load carrying capability and other ways to make sure that you know recognizing that every resource on the supply side, whether it's solar, whether it's coal, whether it's nuclear, they all have certain limitations to their operations, and we need to effectively model that so that you know we recognize what their limitations are and we're balancing that in an effective way, and in a way that recognizes that we don't overbuild and procure for capacity.

MR. VANDERBERG: Thanks Eric. Devin?

MR. HARTMAN: Eric you gave us a lot to chew on there, so I'll start off with the 1 in 10. So the 1 in 10 standard historically has always been more of a metric of convenience than any type of optimization exercise. And so it's really going forward something that is increasingly becoming obsolete.

And we need to -- I think the last year's events have really highlighted importantly the need to distinguish between different types of reliability events, and different really looking at also getting away from just treating all firm load as equal, and assigning like the central estimate of that through an administrative process.

So really getting away from things, whether it's 1 in 10, or if we were to shift it to 1 in 5, or 1 in 15 for different types of reliability events. Also thinking about what is the distribution of the value of lost load? And I know we'll probably have further conversation on this later, but we need to start thinking about like there's just inherent constraints of treating reliability as just an exogenous constraint that's always imposed on these constructs, and start thinking about we facilitate more endogenous reliability in these systems, where as the variance within consumer preferences can really be brought out in the system.

And that's really what should be encouraging, and we have better technology going forward to address this both for the more historic event as well as you know scenarios going forward where we see more extreme events.

And then secondly, I'll point out that when we get into capacity constructs, and I'll note that 49 states do some form of capacity, recognized capacity planning on the gen co side. Some of them just do it more efficiently than others. But we know the capacity markets discussion of FERC purview, we're going to get a lot more attention, and we'll probably get into more about the you know the ELCC and some of these other capacity accreditation mechanisms, especially for the deficiencies in addressing common mode failure.

But I would also emphasize that over the last year we look at which 4 out of the 7 RTOs have implemented involuntary rotating outages over that time period. And really what we're seeing is also a need to have a conversation about capacity procurement outside of just the conventional, you know, mandatory centralized construct.

And so there's a real need to both align reliability institutions at the federal and state level, especially in the cost of service jurisdictions, and we're really seeing that cropping up here in the grid of the future type of conversation in some of those regions.

And so I'd strongly you know when we think about some institutional framework as well as the metrics prospective, as well as the quality of inputs that go into this as we've noted that historical indicators are no longer the sound estimate of the future condition. So a lot to chew on there, but we'll probably dive into each one of these a little bit further later, thanks.

MR. VANDERBERG: Great. Thank you Devin. Mark?

MR. LAUBY: Thank you for that and you now you have to remember where this 1 in 10 came from. I'm old enough to remember. Some of you may be, but it came from the 1960's with Calabrese doing all these calculations over at PJM, and it was like 1 in 8, then they felt like that was suitable for the reliability of those kinds of generating plants at the time.

And they popped it up to 10, like you said it's not economic now. And as I mentioned before capacity equals energy plus reliability of services plus ramping. Now we're not getting that anymore if we just get the 1 day in 10. What we need to do is start thinking about those other paths of the equation. How much energy are you going to need?

How much ramping are you going to need? What are the reliability of services you're going to need? And back out of that what one day or whatever means. Because remember at that time you didn't have computer space, you only had 1 event in 10 because that's all you could model in the 1960's on an IBM 360. So obviously now we can do hours and hours and hours of calculations.

So I think what especially as the importance of electricity has increased, and we can model all the demand response we want. We can do ELCC came out in 1969 with Len Garver, multi-state modeling. We know how to do all of that, but we need to understand exactly what are the actual parameters we need to be modeling to, and what is going to be acceptable given the subsector dependence, and the expansion of electrification.

And to see how that warrants the difference in energy requirements and flexibility requirements and likely service requirements and then figure out what the 1 in whatever is. Again, it used to be cool because you get your 1 in 10, you figure out the dog gone reserve margins.

It don't work that way no more. You've got to get it down to basic principals of what makes up that capacity and what it delivers, thank you.

MR. VANDERBERG: And Neal?

MR. MILLAR: Thank you. So when I hear the discussion around the 1 in 10 it sounds like at one extreme some people are still thinking of it in the context of the way it was calculated 20-30 years ago. And I admit the way I calculated it 30 years ago. But in jurisdictions like ours there's a high penetration of renewable resources, we've had to look even in that probabilistic calculation around what's actually going to serve the load each hour of the day, and what kind of within some reasonable framework of outages, what's your probability around being able to supply load, but you have to be looking at 8760.

As Mark was indicating you can't just think of it as a single point in time. If you are still calculating it that way well that won't work for us, and I suspect it's not working for a lot of you. This probabilistic approach I'll say around the averages is one way to go about it. I don't think a single metric will ever convey all the new conditions that we need to consider.

The amount of assessment that we have to do with the much more diverse league of resources, much different demand side response requires much more careful analytics considering a broader range of conditions, and I totally agree with Alison that we also need to explore what the boundary conditions are so we see an evolution towards probabilistic approaches geared around the center line.

But then also scenario analysis and assessment that have to consider the boundary conditions and effectiveness. And a lot of that really has to come in the longer term resource planning considerations, not just taking whatever falls out the bottom of a model per se, well that's your most economic generation mix, but then you have to test your scenarios.

What sort of common event exposure do you have with that fleet? Does it give you a system that meets the concerns that are emerging for your particular local area. You know for us we're trying to consider a number of these parameters. I admit the fact that smoke contamination from the wildfires in itself caused degradation of performance of solar panels.

It was one of those second order effects behind climate change that we have to take into account. We also have to look at other conditions that are on a more normal basis, but also a broader range of extreme events. In this year's summer assessment work in preparing for this summer we noted that what we used to consider a 1 in 10 peak load are mid and 1 in 5 hadn't changed much, but the 1 in 10 jumped by 5 percent over what we would have previously considered a 1 in 10 event to be.

So there's a broader range of conditions we have to take into account, and we have to study a much broader range of scenarios and conditions because the fleet is capable of that type of broader performance. Thanks.

MR. VANDERBERG: Thank you Neal and let's go to Richard.

MR. TABORS: Thanks. Let me pick up a little bit on Neal and on Mark. One of the things that what we haven't really said so far is that the 1 in 10 and the whole issue of resource adequacy is really intended to focus on do it once and get it right and then move on. And I think the reality at this point is in fact not that, but rather that there's a need to have a relatively continuous process based on what we learn on a whether you want it day by day, hour by hour basis, and I know that in terms of sort of operational planning that's kind of the way the thought process goes, but it's not the way that we're answering what I'd call a stochastically mature way of handling resource adequacy.

We've been working on something called SNAP which is stochastic nodal adequacy pricing which is an effort to take this whole process that's been very engineering oriented and turn it into a stochastic process that's weather driven, and then but then at the end of the day ends up really getting consumers who are the ones that count only in this game, getting consumers a value, something associated with value of lost load that they would then be able to decide well do I want to pay this amount for reliability, or do I not at this point.

In other words there's a sense of price driven response, so to me there's an effort at this stage to getting away from the one day in 10 years which I think by the way calculate what that is in economic terms. It's a rather shocking value that we assume consumers are willing to pay, but ignoring that for the moment, looking at it and saying okay let's get the resource adequacy process into a much more efficient and routine and dynamic process of calculation of probability of there being a problem if you were.

We have this information, weather information today, it's orders of magnitude better than it was two years ago, three years ago, four years ago at the most. So once you dig into that what you find very quickly is gee, you know there's a lot of information here that I didn't have before that I now have, and there's computing technology and capability in the cloud based computing that I didn't have and now I have.

So I can't sort of say gee, I can only do it once a year because it's too difficult. I can do it once a day now. And it's not too difficult. Thank you.

MS. SILVERSTEIN: Eric can I offer a follow-up thought?

MR. VANDERBERG: Absolutely Alison.

MS. SILVERSTEIN: Thank you. The basic premise of 1 in 10 and designing to that has always been if I get this number right everything will be fine. And then the only thing that matters is so you build to 1 in 10 because that's what the standards allow, and then you sit back and essentially assume everything's going to be good.

But you know feeling lucky is not a plan these days, and it doesn't get the job done, and the grid and people, and extreme events are showing that we are not lucky, and that a lot of bad stuff is happening. And so I think that requires us to take a very different approach.

Instead of saying I'm going build to this level then just sit back and wait and trust my operational instincts, and capabilities. That necessitates that we take a really different approach to planning, and then not to solve the probabilistic and scenario stuff that we're talking about, but to me that demands that we go much more to no regrets investments rather than heroics. Thank you.

MR. VANDERBERG: Thank you Alison that's a really good point. One thing I wanted to follow-up on was I think a thread that would bring it through comments from Mark and Neal and Richard was you know taking in more -- slightly differently, but a more probabilistic approach Neal I think you described it as continuing to focus on the center line, but augmenting that with additional what if scenarios.

Can you talk me through how you know an approach like that, or a more probabilistic approach addresses the issue of common mode failure? Once again I think one of the challenges that we're seeing and we're not seeing resources linked in ways that we haven't thought about before previously. We've always kind of thought of resource outages as independent, now we're seeing them linked.

And so just trying to get a better sense of the best approach for dealing with that challenge.

MR. MILLAR: Sure I'd be happy to comment a bit on that. I don't want to suggest that we think we're out of the woods and it's perfect here. Clearly, there's a lot of room for improvements. I think the situation that we're looking at is that we have a number of things that are changing more or less at the same time.

We're moving to a much more reduced GHG fleet. We're also seeing the demands on the existing gas fired generation fleet to be producing less energy, but being available especially for many of the units that are older, more heavily depreciated, a lower cost sort of capacity insurance to help ride through other conditions.

But the analysis now has to focus on how do you make these use limited resources work together to provide an overall reliable system across a pretty reasonable range of possible outcomes around what kind of conditions your system might be facing.

But even after you finish that you still have to look at some of these common mode failures. We've been putting more time on looking at what the gas supply system, what redundancy is on the gas supply system into California. Given the shift in usage for parts of the system where the gas fired system is expected to operate much less than it did in the past, but much more urgently when called upon puts more pressure on the local gas storage fleet for what sort of gas storage capability do you have in certain areas.

So we have to pull it much further back than just what's the mathematical probability of the unit having a mechanical failure. That clearly doesn't cut it. But then even stepping back from that a lot of the initial portfolio development around developing future generation scenarios, or focusing on minimizing cost, but once you've done that even if that gives you a starting point, you then have to look at how that helps you manage reasonable worst case events.

What about an extreme heatwave? What about something that affects you know. We rode through our first fairly major solar eclipse, but we saw it coming, and we were able to adapt with other resources, so you have the system positioned. You're not always so lucky to have you know that kind of notice that you're going to be seeing a shortfall in a particular type of resource.

So I think it's necessary to consider those kind of extreme events that needs to be taken into account and asking yourselves okay I've optimized this fleet, was it really worth from a resilience point of view, getting that last dollar of optimization out. Should we have more resource diversity, and at times for some of these resources we need a bit more redundancy in addition to capacity to ensure that we can reliably operate the system.

And I think some of the same conditions apply also to the transmission planning as well. That even if you go through your normal planning exercise there's still that extra level of review after the fact that does this give you a fleet you can operate? Does it give you a grid you can operate? And have you actually considered the possible range of even you know a minor change in average temperature is one thing, but what we are seeing is that the extreme events are getting much more extreme than what we used to face.

And that's something we really have to take into account to these planning decisions. And that's not a separate exercise. That needs to be baked into the rest of your planning and development activities. It also has to take into account the local conditions that you're experiencing. And that's always a concern to us I admit on the west coast, that a one size fits all approach might address problems that we don't have and miss the boat on the problems that we do have.

So that's where we see that local consideration being critical.

MR. VANDERBERG: Great thank you Neal. I think Richard and then Mark put their hands up next followed by Judith.

MR. TABORS: hey I mean I'm following up really on Mark's -- sorry on Neal's comments that you know common mode events are probably the critical thing, but for most part I think at this stage most of the common mode events have been ignored in the past, but now we know what to look for at least in some probabilistic sense as to what's going on.

The combination of drought, high winds that go with it, thunder and lightening storms, lack of water, those all go together, and they all affect the power sector and with it the natural gas sector. And so one thing I'd like to flag because it's a FERC problem is that essentially the fact that the natural gas market runs on a time clock and a mindset that's incredibly different from the electric mindset and time clock in terms of the market that essentially there's just a desperate need to get information flow, to get data flow, between those two market structures if we expect to be able to use the natural gas, and we're going to have to in order to handle ramping and other issues that are associated with the industry as the industry moves more into more renewable technologies.

And picking up one other pet complaint of mine at the moment that is FERC related, at least, and that is that you know the transmission system we treat that as a fixed asset with no variability and no flexibility in it. And there is a fair amount of technology in transmission optimization, dynamic line ratings, all of which are sitting out there, but nobody uses them because the incentive structure just isn't there to do it.

So you know you look at it and you say what are the two big issues? Yeah, we've got demand response and a lot of other things that are critical, but if you look at it at the moment, the gas supply problem is critical. The transmission lack of flexibility problem is critical. And the fact that we're just ignoring tremendous amounts of information that we actually have that we just don't use in the sense of the stochastics of the system.

MR. VANDERBERG: Thanks Richard. Mark?

MR. LAUBY: Yeah thank you. Of course when NERC has got a white paper out on the website which would work with industry on to really look at this energy issue. And we look at it from three timeframes, nothing surprising here -- long-term, of course like a year or more, a year or less to the day the operational planning, and then of course operations.

And each one of those will require changes in the way in which we currently do our analysis and our planning. And certainly from a long-term perspective what is the energy that I need to deliver, and what are the scenarios that I need to be delivering against, I think that the idea of common modes, or common conditions as we transfer a grid that goes to a grid which is much more sensitive to the weather conditions, understanding those implications.

And then of course how we back that up. And of course from a one year or more of a plan, an operational plan. Now it's more than just winterizing plants, or summarizing plants, this is also around really managing your energy, managing where your demand response is, managing where your units are and maintenance, managing which critical infrastructure load you're serving.

Make sure you continue to serve it, and then go through that process on a seasonal basis, and of course then maybe a rolling 21 day average. Now NERC of course puts its reliability assessments together every year and more and more now we are putting these scenarios together, so we really understand the implications of these we'll call them bookends of serious conditions, and we're learning as you said before the impacts of these common mode failures.

One of course looking at them and lengthening the timeframe, and then understanding again as an industry where we have our folks being electrified. What that means, the kind of resource mix we need to be putting in place to begin with, the wide implementation of those kind of resources, and then ensuring them we can deliver them.

Because many folks are going to be experiencing the same weather at the same time. And we might start thinking about what we mean by extreme events anymore. I mean the idea that an extreme event is 20 below zero for a week in Texas, maybe that's not extreme weather anymore.

Maybe it's something we're going to have to start thinking about a little bit more and this is the way I'm going to plan, this is the way I'm going to operate towards, and start thinking what are the implications of that, how much that load as more folks get more electrified, electric transportation, and dependence on communications and natural gas facilities, and how we would have to serve them because otherwise we don't serve them and they become critical to the operation of the bulk electric system.

How do we manage that as well? So there's a lot yet on our plate to do. I agree with that. And anyway I'm excited about this panel because we're really kind of picking apart some of the important issues.

MR. VANDERBERG: I appreciate that Mark. All right. Let's go to Judith and then Eric.

MS. CURRY: I'd like to make a comment about the extreme heat and cold events. These are associated with massive high pressure systems which can cover like more than half the country. They're also associated with low wind speeds. And they can produce heat and cold events, you know, three days, five days.

Okay. So if you've got these extreme events, temperature events with no wind speeds, and all your neighbors are facing the same thing, where you know it's not like you can rely on your neighboring region to transmit something to you. So you know to me I think this is a big issue with a heat and cold event.

If they're so widespread, they have a lot -- it's not like a hurricane, it's over in a day, you know it's over in a day. These things can go on for several days. Now you can -- we do heat and cold wave probability forecasting in my company, and you can often see you know significant probabilities, maybe 18-20 days in advance, and by the time you know you're 12 or 14 days out you know you can give a pretty good probability that something is going to happen, and by the time it's day 5 or 6 you can really get a sense of the magnitude.

You know is it going to be a record breaker, or whatever. So we really have some information, some weeks in advance, and so you know my question is what's the plan when you see something like this coming? You know it seems like relying on the mix of you know, huge demand, no supply from the wind and the whole region is suffering the same conditions.

I mean what's the plan here.

MR. VANDERBERG: Thank you Judith very good points and very interesting. Eric?

MR. HEINLE: Thanks. I want to go back to something that Richard hinted on, which is the gas electric coordination, and you now when I went through the comments for today for today's technical conference, this was something that a lot of parties hit on, and from a consumer's perspective this is really an opportunity to gain a lot of value for the buck.

You know we've gone through different discussions about fuel security, onsite fuel storage, dual fuel supply for black start facilities, and all of these are significant cost upgrades and infrastructure upgrades that you know will cost consumers quite a bit of money.

And before we sort of leap to those types of costs upgrades, looking at something where we can better coordinate better manage the gas and electric markets so that you now we can get a better sense from delivery, get a better sense of what's available in the pipeline. Making sure that those gas resources that we count on for things like capacity performance in the PJM region are available, and are able to perform, you know, that's really a bang for the buck for consumers and you know much more cost beneficial way of perhaps you know maybe it doesn't address every situation, but it does address a lot of potential you know resilience weaknesses.

And so those are the types of things that the Commission really should be looking at before we sort of jump to the more costly and you know iron in the ground type of solutions. What way can we improve operations? Whether it is gas/electric coordination, or other operations in terms of more conservative operations, by system operators, those types of things, and that can really be a good benefit for consumers.

So I hope that's something that we talk about a little bit here, and the Commission explores.

MR. VANDERBERG: Thank you Eric. I see a couple of panelists that still have their hands up. Were there additional comments folks wanted to make, or are those left over from earlier?

MS. SILVERSTEIN: I have a fresh one if I may?

MR. VANDERBERG: Absolutely.

MS. SILVERSTEIN: Well thank you. All of the -- I agree with everything that the other panelists have said, and it highlights the many, many, many things that can go wrong, and the degree to which grid reliability is teetering on more and more what ifs, and more and more preparations.

So I want to say yet again that given the high number of things that can go wrong on the supply side, let's please put some attention to the ways that we can protect customers from all of those dreadful outcomes on the demand side. And I know that energy efficiency is not classically in FERC's jurisdiction. But then again maybe gas electric coordination isn't exactly in it either.

There's a lot of things that we can do to protect customers that we need to do in cooperation with others. And so, just because all you have is a market's hammer doesn't mean that everything is a nail. We need to find ways to find other solutions and make them work to protect customers.

I mean we are not in this just about electricity. We're in this to serve people, so let's think about how to protect and serve them, not just about electricity for its own sake. Thank you.

MR. LAUBY: And I wanted to mention that we need to engage industry in a broader conversation around what the design basis of the system of the future is really going to be. And this picks up on what Neal was talking about a little better over here. That you know it used to be the N minus one would be the transmission line or a generating station or plant, and then extreme conditions were something you know, and now we're talking about common everyday so-called extreme events that takes out wide swaths of resources and so how do we then respond to that?

What is the design basis for that system? And that would add to kind of the different types of solutions we're talking about, be it demand response, be it energy, whatever. We have to have a real open conversation of what that new design basis is given the transformation of this grid. Not only in the next five years, but in the next 20 years, and then really talk about what that basis is and it may be a little bit different depending on where you are, what's going to be acceptable, but as we have to electrify this country and become more and more dependent on electricity, and in many ways that it can be generated, be distributed, these smart grids or through long distance generation and transmission.

We need to understand what that basis is going to be so that we can ensure that we've built a system that will serve the consumer's needs. As you know Alison says, we're in this because we really care about the end user. We care about reliability. We care about the nation. We care about the North American continent.

MR. VANDERBERG: Thank you Mark and that's actually a great segue into the next question that I was going to tee up for this group which is about the current approach that we're taking to transmission planning, so I want to shift gears a little bit and talk about transmission planning. Mark as you were eluding to a minute ago, you know, the current approach that we have in the NERC standards in TPL1 is a deterministic approach.

We have planned contingencies. We have definite performance criteria. As Neal noted at the outset there is a framework there to have entities look at these wide area events, evaluate the potential impacts, but it is just that as a framework. It doesn't you know, establish that design basis, nor does it require any type of you know mandatory corrective actions or anything to that affect, so the question I wanted to pose to the panel is how should the current deterministic approach that we are taking with the transmission planning, how should that evolve in light of the threats posed by extreme weather that we've been talking about here?

I think Richard was first followed by Devin, so let's go in that order.

MR. TABORS: Okay. I think transmission planning is a real bugaboo and I will take some responsibility for having taken transmission and swept it under the rug when we were doing the restructuring of the power industry and 808 little things like that, so I have some guilt on this.

On the other hand, I think that something that is absolutely critical at this point is that until there's an economic incentive for transmission owners to try and be creative, and try and do things that are creative in terms of operating efficiently, we're really stuck in a hole with the ability to plan transmission.

I mean what it means today that we all agree is wrong I think, is that what I have to do is I have to build more wires and bigger wires in order to hook more things up, when in fact we've got a ton of wires. Let's try and figure out how to run them and operate them more efficiently, which there are technologies to do that as I said before.

So I think one of the issues with transmission planning is to say what is it I'm trying to do? And Alison's raised this thing. Mark raised it. I think it's a real question to go back to the drawing board and say you know what is it that we expect transmission to do, where and how do we want to evolve that process intelligently, and effectively and efficiently. Big word on efficiently.

Building transmission lines is expensive. We've got a whole lot of them and some of them aren't where we want them, but a lot of them are where we want them. How do we start with what we have because you can't sort of say oh, I've got to build it from scratch.

I'm sorry the chances of building it from scratch are real close to zero. Thanks.

MR. VANDERBERG: Thank you Devin?

MR. HARTMAN: Yeah I think this is a great example of where we have deficiencies I the existing planning process and factoring in climate considerations are just going to be like all right, like more you know stronger case in point now to reform this arena.

And I think you can kind of segment it into interregional, regional, local, and I'll just make some high level global observations so we can avoid you know some region specific issues here. But I'll just say from an evaluation perspective, because that might give a little bit more to the deterministic question, we're seeing a couple pronounced problems in transmission planning kind of manifest in a few areas.

So one is like we keep thinking that economic and reliability considerations have to be siloed, and so we're like constantly putting everything into an economic bin, calculating those types of projects and doing that, and then there's a reliability project bin and if we're going to have this conversation and really move forward we need to start talking about like the value of reliability is inherently economic, and we need to start talking about co-optimizing it, what we call limited economic benefits today, with the broader reliability benefit.

And we're seeing that especially play out in the regional processes, right? And then on the interregional side there's a few RTO experiments I think broadly everyone would say interregional planning has been disappointing, but as it relates to the -- approach, I'd emphasize that like even a couple of the regions that have started to take next steps to collaboratively work together are really struggling to come up with a common set of benefits.

It's like the basic, like the rubric to even define like how to proceed going forward. So if we can't even get like the more conventional benefits really ironed out between regions, that's big, and I think that you do inherently within the system have a bunch of fundamental questions about for example how independent the RTOs are going to be in the transmission planning process.

That's everything on the criteria upfront to project selection, and then you -- we've got a framework that looks at a lot of regulatory arbitrage occur in the planning process, and then that's really still not also even outside of the Order 1000 context when you look at some of the most vulnerable areas to extreme weather and transmission repercussions.

A lot of times you see a massive amount of variance between the reliability performance within a single region right. We sort of have these chronic dead zones if you will right. And there's reason that those dead zones have persisted for a long time now. We're not seeing customer valuation of reliability manifested in the planning process evenly across these spatial elements right.

And we're seeing a systematic suppression of competitive forces, and a lot of these competitive forces, especially new entrants want to pair with end users, and I think listening from transmission dependent utilities we're really learning a lot more because they're tremendous case studies.

But if you talk about extreme weather, those are some of the most disaffected parties right now. So overall think about addressing transmission planning deficiencies at those three scales is a great place to begin thanks.

MR. VANDERBERG: Thank you Devin. Alison?

MS. SILVERSTEIN: Thank you. So transmission planning and it's inadequacies matter because the nation cannot possibly achieve our decarbonization goals without more transmission period. Richard is right that we can make existing transmission more efficient and effective, but that doesn't change the fact that all of our most productive renewable resource areas will need to be opened up through new transmission.

And getting those to our greatest customer concentrations, and where electrification will have the greatest impact requires more transmission. So more transmission is non-negotiable for the sake of achieving decarbonization. And as many of the panelists discussed on the last panel, for a reliability point of view transmission is an absolutely essential reliability tool and protector.

So it's not enough to just say -- to wring your hands and say we need more transmission. We do need more transmission, and it's very obvious that the current methods aren't working, and the current processes and systems aren't working. So instead of trying to go incremental we need to say look, they aren't working we need something better.

And that means starting fresh on a whole lot of stuff and building on, but not being handcuffed by the current systems that we have. We need a significantly new form of benefits definition that is significantly broader. We need it to encompass what benefits do we measure.

We need it to count more benefits to more people. And we need it to cover a much longer point in time. And this kind of needs to be consistent as well as the planning processes and the metrics and the cost allocation tools need to be consistent across both regional, intraregional and interregional transmission because too many people are getting screwed by the lack of transmission, and by the lack of participation and representation in a lot of these critical conversations and processes.

So just saying let's tweak around the edges is not going to change this in any way, shape or form, that's the definition of insanity. We need much better tools. We need much better processes. And we need to do a complete shake the etch-o-sketch as one of my old bosses used to say all the time, of transmission planning and my recommendation for large intraregional and interregional is that we create a national electric transmission authority that is responsible for developing -- working with everybody in the came to develop a lot of these tools and make them applicable across the entire nation in every region.

Because if we just have the tyranny of every state's small benefits, old-fashion calculation methods, we are never going to break out of the permitting trap, or the cost allocation trap, or the cost effectiveness trap. So I think we need to just start fresh because we can't do decarb without it. Thank you.

MR. VANDERBERG: Thank you Alison. Eric?

MR. HEINLE: So to add on to what other folks have said. I think you know all the benefits of both inter and intraregional transmission planning, whether it's decarbonization, whether it's improve resiliency, they simply can't happen unless or until the Commission I think frankly, really steps up and looks at federal ways to conduct transmission planning, encourages the RTOs to look for more authority.

You know the RTOs they're called regional transmission organizations. They should be the regional planner. But quite often when we see the transmission is planned in a very vulcanized way, it's planned state by state, transmission zone by transmission zone, and perhaps that works great for that state, or that transmission zone, but it also then doesn't work to serve the region and certainly not on a more national scale.

And so I think the Commission really needs to look at really I would say invigorating Order 1000 and looking for ways to encourage much more regional planning, much more direction from the Commission, from the RTOs, perhaps something like Alison suggested with a national transmission planning authority. I also think to me as a consumer advocate it's always been a mystery why we look to market to solve a lot of the issues with capacity, energy, reliability.

But with transmission we still really rely on right of first refusal, and sort of you know with few exceptions, the transmission owners have sort of the you know, an almost inherent in terms of redeveloping transmission and again, you know, sometimes they make great choices, sometimes they make less than good choices, but prudence of user are very difficult to do.

So it's frankly very difficult from a consumer perspective to challenge them. And again it doesn't look at you know, not only is this the right choice for this area, but who's the right choice for the region you know especially look at nine wires alternatives. Stuff like storage, again really we need the Commission to be a little bit more invigorated.

We need RTOs to be a little bit more empowered to direct the transmission for the region that they are serving. So you know I think that's where we need to start, and then we can start looking at potential benefits of inter and intraregional planning. But before we do that it's really going to be hard to capture those benefits.

MR. VANDERBERG Thank you Eric. Neal? Neal if you're speaking you're on mute.

MR. MILLAR: Okay sorry about that. I was going to say this is where I was wanting to jump in such for a minute because this is a concern for us in the west and in the ISO in particular. When I'm hearing broad generalizations being spread about all ISO's do this, or all RTO's do this, all transmission owners do this.

There are differences in the different areas and those need to be taken into account. California is a little unique where CALISO has about 80 percent to the state inside our footprint as well as the small portion of Nevada, so a lot of people consider that to be a one state ISO. Within our region we believe our regional processes have been very effective.

We do see they're at a reflection point where we need to advance considerably more transmission to move past the solar development that's gotten us to this point. We see we need an inflection point to build, to capitalize on other resource diversity to move beyond the penetration of renewables that we've achieved to this point, even with augmenting the solar with considerable storage, we do need to expand the diversity of the fleet and that is going to take more transmission.

But those processes have been successful in getting us to this point with quite a bit of transmission being built to support them. Admittedly, on the interregional side that's where some of the discussions have gotten a bit bogged down, especially by parties who are following the letter of Order 1000 when it came to interregional planning.

But we're largely doing that as the most that you shall do as opposed to the floor of what you should do, and then consider future opportunities beyond that. When we look at competitive solicitation and incentives, we think our competitor solicitation process has been extremely successful.

We've gone through that process for 12 major projects that were put out for competitive procurement, and 7 of those went to independents, and 2 to consortiums that included incumbents, but also included independents. So I think those processes have been quite successful.

So we get concerned when we hear the broad generalizations made about a particular process is completely broken. Well there may be cases of that and that's something FERC should certainly take a look at, but that's where like I said applying a broad brush at times can be a concern where people have different sorts of issues that they're dealing with, and different sets of circumstances.

MR. VANDERBERG: Very good. Thank you Neal. Richard?

MR. TABORS: Yeah just I just want to sort of pick up on one of Alison's points, and also on Neal's. I'm in total agreement that effectively transmission has to be handled regionally. And my only comment of a negative nature is that the ISO's that I work with, which tend to be on the east coast, not California have -- are operating when it comes to transmission you frequently have the feeling that the ISO is owned by the transmission owners in the sense of when you try and get something done you run smack into try and get something true in ISO you run smack into the transmission owners.

On a side they use a very different tack on this. I'm in total agreement. I think with Alison that we've got a plan. We've got to get it you know national, and it's got to get interregional. I would really emphasize the fact that in order to make any of the goals that any of the states have at this point on decarbonization and the use of transmission, we've got to use the existing transmission more effectively than we do today.

And we're just not doing it. And so that's the question of how do you go from where we are to a regional interregional transmission system? The answer is -- and the carbon impact of it, if what I'm really worried about is carbon then the first answer is I got to run the system that I have now better than I do.

And oh, by the way, I've got a plan for the future. Getting transmission built is a 10 year process if you're lucky. Getting out there and making the transmission system more efficient is a one to two year process. Let's get that one to two year process done and move ahead. Thank you.

MR. VANDERBERG: Great. Thank you Richard. And I believe Commissioner Clements has a question.

COMMISSIONER CLEMENTS: Thanks Eric. I wanted to follow-up on Alison's proposal, appreciating everything that got said from you know the demand side all the way up to making the current system more efficient. At some point to the need that Alison described if you accept her premise.

And can you talk to me, provide some more specificity Alison? Is this something that the Commission would do? This national entity? And would it be -- have you thought about it enough to provide details around whether or not it lives outside of the RTOs, or is connected to them? I'm just wondering if you have any more specifics.

MS. SILVERSTEIN: I have a few specifics. I've been thinking about this and working on it with a few other people. And so we haven't worked out all the details yet. I think there's plenty of room for improvement on these ideas. It clearly needs to be empowered by FERC and supported with the intellectual muscle and funds of the Department of Energy because we know that many excellent transmission and planning tools and things like benefits analyses and methodologies have already come out of the Department of Energy and are floating around.

It's FERC's job to get transmission built by I assume, or at least to find effective ways to plan and build transmission. It's also FERC's commitment to figure out how to get appropriate participation, rooting, et cetera, and identification of benefits and the cost allocation that follows from that.

So I view it as FERC's job to figure out how to whether it is frankly just and reasonable to use a bunch of outmoded benefits calculation methods, and a bunch of overly short horizon benefits timeframes, or cost allocation methods that don't reflect the full scope of beneficiaries from transmission, particularly interregional transmission over not just a 10 or 20 year period, but a 40 or 50 year period.

So I think there's a lot of room for FERC to decide that maybe there is an opportunity and a need and justification for broad sweeping reform of almost every element of the transmission planning process.

Now clearly small local transmission processes are working. We know how to do that. But equally clearly large intraregional in many cases, and large interregional high-voltage transmission backbone is absolutely not working, and so I think that if FERC thinks there is a national benefit to making that happen, I think you have an obligation to pull people together and figure out how to make that happen, and what to do about it.

The energy systems integration group is I believe working up a paper that will be made public on this soon, and I think also the folks at the -- Center have been thinking about it a lot and doing some really good foundational work on this question as well thank you.

COMMISSIONER CLEMENTS: Thank you and since you brought it up I'll just lob one more question to you and your fellow panelists before turning off my camera. The benefits question. You've spoken about thinking about consequences, not causes.

We all have there's been several comments inferring that the determination of benefits investment upfront may be different than who benefits from those investments later and I'm just curious if you all could say a little bit more about your thinking on how at least the FERC and appreciating the split jurisdiction on a lot of those questions, or at least multi-layered jurisdiction, how we think about the part that is FERC jurisdictional. Thanks.

MS. SILVERSTEIN: Well almost everything that's reliability related is FERC jurisdictional, and that includes things like whether we have -- whether Texas has interconnection to the rest of the nation, and could have gotten black start had we needed it. The answer is clearly no.

And so we could have been deeply out of luck had we not come back from the brink by dropping 25 gig of customer load. The consequence of the fundamental benefit of transmission is not merely that it is a supplement to capacity or a way to bring in energy or ramping when you need it, it's that it creates this foundation of flexibility and optionality.

Because again and again we find that we built transmission for one reason, and it turns out to be valuable for 12 others. It's like the Swiss army knife of the grid, you know, we built CREZ to be able to develop renewables in west Texas, and it's powering fracking. Where some of the fastest electric growth of the nation is in west Texas for natural gas wells. You may not like them, but transmission made that, enabled that development.

Again and again we build one thing for economics, and it turns out to be reliability essential, or we built it for reliability, and it turns out to lower everybody's market power and delivered cost. Transmission just keeps delivering. So even if we -- I don't think we give enough credit to those optionality benefits, wholly apart from the facilitation of decarbonization, or the reduction of market power, and those kinds of things.

And so there's a much broader set of benefits that need to be recognized and accredited, thank you.

MR. VANDERBERG: Thank you Alison. I see Devin and Eric with hands raised. Would you two like to weigh in on that question as well?

MR. HARTMAN: Sure and if it's okay Eric, I'd like to chime in on the first question that Commissioner

Clements posed as well. So first off I think Alison's idea is very interesting because it addresses the institutional question which I think really lies at the fundamental element of how to fix interregional planning processes.

To a point Neal made earlier the quality of transmission planning varies a lot by region. CAISO, in my opinion, does a lot of things better than some of the other regions for what it's worth. When it comes to interregional though it's very clear that something's broken, and just tinkering around the edges, we don't know how much benefit we'll get out of that.

It's important keeping in mind to another point that was raised that you know these are voluntary organizations, largely where membership is driven by incumbent transmission owners. There's always going to be some favoritism to those incumbents. RTO staff have even admitted to that before, and so we have to rate the bottom of the question to what extent do we actually have independent transmission planning framework in place -- it's actually for interregional right?

And this problem hasn't even been isolated, just the transmission to look at like what seems management issues have been lingering in the state of the market's reports or recommendations for market monitors for years now. A lot of this goes into interregional trade right?

There's always going to be incumbent interests that do not have some interest and enhancing the ability to import power. And if there's a dominant player in the governance process, well we're going to have a challenge, especially if RTOs consider on the first among equals.

And so I think that Alison's idea is one idea to definitely address that institutional problem. And then on the benefit side part of it is to make sure that we're holistically including all categories of transmission benefits in the integrative process rather than the silo. I mentioned economic and reliability projects, but there's also the public policy objectives of the state that Order 1000 acknowledges.

I know that in the past that's been controversial in terms of how it's been viewed as legitimate by some past leadership at FERC. I would stress the need to just treat that as an exogenous and put that as something that is not -- should not be in the judgment of the Commission to you know, to validate or invalidate, but just to say things like state's RPS policies are there. This is where they're going, and we need to be building that into the input rather than kind of putting it in that separate bin all together.

And so we really need to do a more integrated cost of some of the benefits, the valuation side which will really help the four regional. It's helpful with interregional, but unless we address that fundamental institutional dilemma, I'm not sure how many strides we can make on that front.

MR. VANDERBERG: Great thank you Devin. Eric?

MR. HEINLE: Thank you Eric and I also wanted to address Commissioner Clements great question about cost benefit. You know from a ratepayer standpoint you know the old saying was reliability at least cost. And I think we need to sort of maybe change that paradigm a little bit and look instead for cost effective reliability, sustainability.

And part of reaching that is when you look at something like transmission you look at the value of that for example, it brings to decarbonization, and maybe you say you know this transmission asset it's construction will result in your know a cost of carbon reduction by such and such.

And for that reason loads should be assigned because they benefit from that reduction to that cost in the transmission in addition to sort of traditional generator pays for transmission upgrades. But I think also, and it's a little more trickier to do with reliability and resilience because as we've discussed here today, finding those metrics for what creates reliability and resilience, and what the value of reliability and resilience are, are a little more difficult.

But I think you could do something again very similar where you could say this transmission asset you know, brings a certain level of reliability or resilience to the system, and again that reliability and resilience has value per load, and loads certainly pay for things that have clearly defined benefits for it.

And again we have to make sure that those benefits are clearly defined, and that you know the modeling is reasonably good, but I think if we do that, that is one way to address the cost allocation issue.

MR. VANDERBERG: Thank you Eric. Richard?

MR. TABORS: Yeah just a real quick comment on this one and that is that a lot of the work that we've been doing lately in my world really does work on the stochastics of resource adequacy, and one element of that is in fact the ability to really price reliability provided by transmission -- in other words, value economically the value that transmission is providing, or I might indicate not providing if you look at the economics of it.

So just a comment back to wherever Commissioner Clements started that question.

MR. VANDERBERG: Very good thank you Richard. I believe that is all the hand raises. So we have about a half hour left in our panel. Time is really flying, and so I want to make sure that the other Commissioners here have an opportunity to ask questions as well, so I'll turn to Chairman Glick to see if he has any questions.

CHAIRMAN GLICK: Thank you Eric. I did have one question at least, and maybe another. But if I could start maybe Richard you had mentioned earlier you talked about earlier the need to make things in the transmission grid more efficient in addition to going towards transmission capacity. And I agree with both points actually.

I was wondering in addition to dynamic line ratings and in the ratings and so on, are there other things we could be doing, or should be doing or looking at in terms of improving the efficiency of the existing grid?

MR. TABORS: I suspect the answer Mr. Chairman is you know we work on topology optimization. And topology optimization is nothing more than -- I say nothing more, very wise software that basically allows us to look at how to reroute power through the transmission grid.

And so the answer in part is you know we know how to do it. We've known for a while how to do it, but the question is how do you get -- how do you get the transmission owner to say, or the transmission owner/operator to say yes, we'll look at the alternatives that you're bringing to us and then make a decision as to whether from our analytic perspective, that's a good thing to do, or not a good thing to do.

So I think there's that channel down there, and I think you know if you really were to raise a flag and say hey, give me a bunch of good ideas about how to run the transmission system more effectively, like I having I think -- well like will occur with I suspect the technical conference in maybe September, whenever the next one on transmission is.

You know I think there are a lot of ideas. There are a lot of bright people running around out there that I'm not convinced really look at this problem as being as truly important as it is. These are huge asset bases that we have, and we're not doing a very good job of operating them.

MR. VANDERBERG: Thank you Richard. I also see Alison with her hand up.

MS. SILVERSTEIN: Thank you. I need to support 11 years of my professional career by reminding us that there's lots of synchrophasor data enabled analytical solutions that can be used to operate the grid more effectively.

And I also want to point out that we could be using it -- at the risk of sounding like a broken record, we could be using geographically and topologically targeted energy efficiency and demand response to help decongest the grid, and to improve voltage and deliver a lot of ancillary services that would take some of the pressure off the transmission system. Thank you.

MR. VANDERBERG: Thank you Alison. No more hands up Mr. Chairman.

CHAIRMAN GLICK: Thanks Eric. Actually Alison, that's a very good segue into my second and probably final question which is you've mentioned earlier the importance of energy efficiency and I agree wholeheartedly with what you said. Obviously, transmission is an extremely important element that we're going to be spending a lot of time with over the next year or so, but you know I think there's a dichotomy and you know this better than anybody, between you know the items we have authority over at FERC, of course the items the states have.

So it's not just energy efficiency, it's also DERs behind the meter, generation facilities that don't necessarily compete or participate in the wholesale markets, but also who do play a huge role addressing resource adequacy and reliability issues, especially in terms of improving our resilience in the face of extreme weather.

I'm wondering, you know you've actually worked with FERC, you obviously spent a lot of time on the state side as well. I was wondering if you had any advice for us as to how we could address those issues given our jurisdictional constraints and limitations?

MS. SILVERSTEIN: One consideration is a long time ago when I was at FERC, one of the things that we did was to -- we were trying to solve the southwest congestion issue. And because it was taking a long time to get new transmission built, one of the things that we actually did was to tell the ISO New England that they could build transmission, but if we all truly believed that energy efficiency and demand response were valid alternatives, as non-wired solutions, then anything that they did within on energy efficiency and demand response significantly alleviated that transmission constraint that they could implement within the same period as the transmission approvals were pending would be uplifted.

That they could implement it and those costs would be uplifted across all of New England customers in the same way that the corresponding transmission solution would have been. That's one possibility. Another is to remind state regulators who are going to be bearing the costs of new transmission that FERC approves, that there are multiple ways to skin these cats, and that there are three sets of costs that need to be compared.

One of them is the classic transmission and supply side solution. The second is the -- what are the non-wire supply alternatives or compliments that can help make this happen, and the third is if we can't do any of these how bad could it get? And invite people to compare these three sets of costs and consequences, and pick their poison.

Because if we can achieve solutions that combine non-wire solutions and transmission and clean energy solutions on the supply side, with a significantly better benefits on lower cost solution then getting into the climate change and disaster car wreck that's going to cause the kinds of human and social and economic costs that we saw here in Texas in February.

If I were back in my state regulator role I would be pretty willing to help make some of those energy efficiency side solutions happen. And I would also prefer having the option to help control that fate. If to being ordered by the federal Congress -- hypothetically assuming that Congress were willing to act, it would be ideal to be able to design our own fate and pick our own preferred solutions rather than just saying you're not the boss of me, and let my people sit in the cold rather than be protected. Thank you.

CHAIRMAN GLICK: Thank you.

MR. VANDERBERG: Does anyone else want to comment on that? I believe Neal has his hand raised, so let's go to Neal and then I see Eric and Devin with their hand raised also, so Neal first then Eric and Devin.

MR. MILLAR: Yes. And thank you for the chance to comment on this. Obviously, like in California there's considerable emphasis on energy efficiency. Trying to capture demand response programs in a way they can effectively help, not only on a system-wide basis, but we also employ demand response programs in our local resource planning as well, so very heavy emphasis on those programs.

That being said though we are also expecting increased electrification both in transportation as well as buildings, that despite those efforts we do see upward pressure on our load forecast going forward, and we do think that will put increased pressure on the transmission system to deliver, as well as access the need to access other types of resources that we currently can't capture with the transmission system we have.

Offshore wind, out of state wind projects and so forth will push beyond the existing systems capability. So while we put a great deal of emphasis on those other alternatives on the demand side, whether it's energy efficiency, demand response programs, we do see that we are going to have to be pushing the boundaries and getting some additional transmission built to capitalize and to allow those other industries to decarbonize.

We just can't get there with the measures that have gotten us to this point. So I just wanted to be clear about that, so I hope that helps. Thank you.

MR. VANDERBERG: Okay. Thanks. I think Devin we're going to go to Devin and Eric and then I know Alison wants to circle back and make a clarification after that. So let's go to Devin and Eric.

MR. HARTMAN: Sure. Thank you Mr. Chairman. I think it's encouraging to hear the DER/general demand side of the equation being brought up in all of this. And I think it's one of the big lessons learned through the Texas and California here recently too, where a lot of the initial conversation was very fixated on what went wrong on the supply side.

But going forward as much as a reliability policy conversation has to be on the demand side. Alison and my colleague of the former ERCOT market would have been great on this is the fall out of Texas, and we've fortunately been able to get a lot of traction on it.

It is for the Commission given jurisdictional elements, but going forward there's a few principles that would really be helpful going forward and that's thinking about the Commission's role of going forward and systematically identifying how to reduce barriers to entry, information asymmetries and transaction costs, especially as it relates to really all forms and DERs, but also being more cognizant than we have the potential to unlock so many opportunities to provide a physical hedge to reliability.

But historically it always had to be industrial CHP or pretty much nothing else. Now we're seeing just a portion of technology has emerged, and really the reliability value of investments is so much greater downstream, and the ability for a lot of these entities to physically hedge just needs to be there, and it's very important for the system overall. And a lot of them can help also on the resilient side from the bounce back angle too.

So there's a ton of opportunity to manage emerging reliability threats better with emerging technology, and the last point I'll really make is when we think about tangible forms especially for DR we need to think about more opportunities for unlocking both economic DR, as well as emergency DR.

And one of the things that we missed out on in the economic side I should say, we're looking at both the supply side treatment of it, DR as a supply side equivalent which is naturally difficult because it's an imperfect substitute for generation in many forms, but also really get in deep DR we need to think about cultivating pressure on the demand, and that goes into the overarching constructs behind the role of energy and ancillary services and capacity as well.

And then on the emergency side, what we really need to be thinking about a bare minimum, starting to have better emergency protocols that can isolate and control power flows better to high value those uses, both to avoid outages for the customers that value it the most, but then also making sure that the ones that were the value of offload is very duration sensitive, that we can get those customers prioritized on the restoration side.

So there's really both a massive amount of work that can be done on this front, and it's huge both for adjusting to avoid the more extreme weather, as well as integrating those type of technologies that are going to help assist in decarbonizing, thank you.

MR. HEINLE: Chairman Glick thank you for the question and I think you know at the risk of I'm a state employee, so at the risk of getting in trouble for blurring the states and federal boundaries that we certainly support, the Commission can play an important role incenting. Resources like DR, DER storage and you now it did a great job with Order 841, Order 2222, those were significant steps forward in breaking down barriers for these resources to participate in the market.

But you know I think we need to look at other options and other ways to again encourage those resources. We talked a lot about incentives from the supply side with respect to capacity markets, with respect to energy markets.

We also need to look at incentives for load side participation and response to operations in the grid.

You know we should explore whether there are options in terms of islanding that also makes sense for the Commission to encourage through an order that might be similar to 2222 or 841. And so I think really again looking at ways to incent the states to do the right thing.

I think most states want to do the right thing, and providing the basis for the state commissions then to go to their respective ratepayers and say you know, we now have a concept that allows us to support these behind the meter resources and these load resources as a way to hedge against extreme weather and other resilience factors.

So again I think creating the right incentives, the right atmosphere and opportunities for those resources to you know really flourish is something the Commission can do, so thank you.

MR. VANDERBERG: Thank you Eric. And back to Alison.

MS. SILVERSTEIN: Thank you and to close out this important question Mr. Chairman, I want to be the first to acknowledge the customer side, demand side resources are not going to -- or distributed energy resources broadly, will never obviate the need for more transmission and generation. Let's be absolutely frank about that.

But I like Devin's framing of demand and DER fixes as a physical hedge for reliability, and let me be more explicit about that. For resilience purposes measures like energy efficiency keep customers alive against the almost certain consequences of grid failure. And we know the grid is going to fail again, and again, and again.

Whether it's local, whether it's a city or whether it's God forbid another ERCOT. So with increasing heatwaves, increased higher temperatures, colder cold, more flooding, anything that we can do to change customer premises to keep them alive when the grid fails for whatever reason is an investment that is probably worth doing.

The other reason that these resources have value is we can do them faster than we can do transmission sadly, which those of you who have done energy efficiency know it's not fast or easy, but God knows it's faster as PV and storage and a lot of other things, and building new interregional transmission.

So that doing more energy efficiency and distributed resources gives us time. It reduces stress on the grid. Every time we do more energy efficient air-conditioners, and more energy efficient heaters, we lower the odds of the next summer heatwave failure, or the next ERCOT disaster, because we've lessened demand at that peak.

And given us more tools to stabilize with demand flexibility, and it gives us more time to figure out how to work this whole new set of markets and resources that are new to all of us frankly, and we are in unstudied space.

So the more that we can use demand side resources and distributed resources to buy time and destress the supply side in the operation of the grid, the better off we're all going to be. Thank you.

CHAIRMAN GLICK: Thank you. I just wanted to follow-up on that point. I agree with you wholeheartedly first of all. We definitely need a significant amount of new transmission capacity, but it does take time. It's not an easy issue. We need to look at alternatives which include efficiency, behind the meter generation, demand response, but also as Richard mentioned earlier, making the existing grid more efficient, or operating the existing grid more efficiently.

So I think you know kind of all of the above situation, but I think we have a big challenge on our hands, and I think we need to figure out a way to take advantage of all of our options. Thank you Eric.

MR. VANDERBERG: Thank you. At this time I'll just ask any other Commissioner questions? No. Okay. Well we are actually near the end of the panel. We have about 15 minutes left, so one thing I would like to do as we look towards closing would be just to go through all of our panelists and again, we have a couple of our Commissioners here today with us, and I know it's difficult, but I wanted to see if we can boil it down to one or two things that we should take away -- we being this Commission, as action items from this discussion.

If folks are able to kind of boil it down to kind of of one or two action items that we should take away from this I think very informative wide-ranging discussion that would be really helpful to kind of personalize what we've heard today. So interested to hear from everyone, so I will start with Judith.

MS. CURRY: Okay thank you. I guess from my perspective from the weather and climate space, I'll reiterate the point that there's a lot of information out there on the table that's not being adequately used from the weather forecasts to information about future scenarios, not just from the climate model, but there's a lot more that we know about the climate system in terms of natural variability and things that we can expect in the coming decades.

In terms of what we understand about the climate system we're on much more comfortable ground going out 30 years in the future, since we're talking about going out to 2100 it's much more uncertain. So the extent that we can take advantage of the greater confidence that we have in our understanding of how the next 30 years might play out, I think would be a useful focus because that's the lifetime of a lot of infrastructure, and certain things.

I mean we don't need to figure out what's going to happen in 2100. And the other point is you know on the weather time scale, and here's where the probabilistic forecast comes in, we have information out to week three, you know, probabilities. I mean our understanding and our confidence increases as we get closer.

But there's a lot of information there that can be used in the context of decision-making, whether it's probabilistic based decision-making, or whether it's tied to operational things, or scheduled maintenance for power plants, things like that.

You know paying attention to a possible cold wave in week three with all those power plants in Texas being down for maintenance, that's something that the information was there to say don't shut those power plants down for maintenance. So again, just to reiterate, there's a lot of information out there that we can make better use of you know in the sort of climate and weather space.

MR. VANDERBERG: Great, thank you Judith. Next we'll go to Neal followed by Mark.

MR. MILLAR: Thank you. First, I'd just like to reiterate and especially point to some of the comments made by panelists in the first session, that the climate change adaptation covers a whole range of activities from detailed engineering efforts around standards for construction and so forth, through transmission planning all the way to the longer term resource planning activities. So this isn't just a single topic, this is a whole spectrum.

And that the climate change considerations need to really be baked into processes whether they're fine as they are, or need to be redesigned. These kinds of considerations need to be baked into all of those planning processes, so that we're reliable at every stage of the way.

And in doing that we also need to make sure that we, like I said, and I know that I mentioned this before, but we really need to take into account the local challenges that people are dealing with that are specific to the geography as opposed to applying broad brush solutions that cause additional work without necessarily addressing the challenges that that area itself is experiencing.

So that's just one of our major concerns we keep coming back to on trying to effectively integrate climate change adaptation into the rest of the transmission design, planning, and resource planning considerations. And thank you for the opportunity to speak on the panel today. We do appreciate it.

MR. VANDERBERG: Thank you Neal. If I may I'd like to follow-up on one thing you said really quickly. Baking in you know climate change into all aspects of the assessment process. Can you talk a little bit more about that? It sounds like that's something you've done at the ISO, at least to some extent, so could you just unpack that a little bit more?

MR. MILLAR: Well one example for is -- sure, I'll touch on two quick examples. One that was specific to climate change is our consideration of the need for a more diverse resource fleet that California has done a lot of decarbonization over the last decade focusing on solar resources, and now augmenting with storage.

We do see thought that that caps out with this inflection point where we need to access other types of resources. And that's where we need to apply a second review of what all the modeling techniques tell you is the right solution. Because a lot of the parameters we're dealing with today I doubt can ever be successfully built into a probabilistic analysis.

You know if you try to calculate the odds of a forest fire being so severe it creates its own weather system. Like these kinds of issues that are real to us, and that have to be considered at some level, just won't find their way through a probabilistic analysis to actually affect an outcome.

So that's where we see that we always need to also apply that pragmatic consideration of what your models are telling you to land on a path forward. This is something we did employ, but it was for a different cause, but we did employ this type of technique looking at the San Francisco greater Bay area, and looking at earthquake risks.

Where the obvious solution was to start building more transmission. But what it really led to was a hard main, instead of the main grid, a hardening of the sub-transmission system which is where the vulnerabilities actually is arrested. And that involved looking at various scenarios of extremes of earthquake events.

So this type of consideration being applied above the conventional planning process we think is critical. And it's not a replacement. After all is said and done if we mill the ball on an N minus 1 outage, and cause a disruption in an area, that's going to haunt us too. So this is as well as, not instead of. Thanks Eric.

MR. VANDERBERG: Yeah, thank you Neal. Very good point. We are not that far removed from 2011 where we had an N minus 1 outage, it caused a big blackout, so we certainly can't take our eye off the ball there either, so. Let's go to Mark, followed by Devin.

MR. LAUBY: I have two points. One is of course start looking again at planning in the three timeframes. And certainly, we're looking at long term as some of the bookends, consider in back in the day what happens if all nuclear plants have shut down? Look at what those kinds of scenarios look like so that you can make a plan around those and to a sensible resource mix that's going to deliver the energy, the reliability services, and the ramping that you're going to need.

And it can be a multitude of different solutions, including transmission, energy efficiency, all the whole host that we talked about and more. And then from more of a shorter term start planning that season ahead and use all the tools available to you and of course in the day of, and have a rolling 21 day because you get more information as you go forward, so think about that framework, and build new methods and tools and planning around those.

Second it's a design basis. What we have today, and what we've been designing to is not I don't think going to be acceptable in the future in the reliability of the future when we have a society that is very much electrified, very much dependent on good, clean, affordable electricity.

We need to understand what those implications, are, how we mix the smart grids with the long distance transmission we're talking about and the energy efficiency and all that, how we tie that all in to be able to get to a design basis that delivers the kind of reliability security resilience that we expect in the grid. Thank you.

MR. VANDERBERG: Thank you Mark. Devin?

MR. HARTMAN: Thank you. I think climate change simply makes a more compelling case to do a better job but for reliability policy. Plain and simple. And that boils down to a couple simple concepts that are a little bit harder to execute in practice. One is getting economic thought infused into all of our reliability institutions, and decision-making processes.

And then the second point is getting our reliability institutions better coordinated. To the first point for example, if you're talking about a design basis for future standards to Mark's point. If you're developing in standards development or the reconsideration of standards in the NERC domain, we need to factor in at least for a major consideration an objective of trying to maximize net benefits to consumers.

That's ultimately who we care about. But then also on the coordination side we need to talk -- we need to recognize that there is an increasing codependence between all these different sets of actors that influence the investment and asset management of both the generation side, transmission as well as in the downstream distribution and DER space.

And right now there's such confusion of what institutions are responsible for what, and a lot of this came out in response to the California and Texas events. So really stepping up to make sure that we can get better higher-quality information and coordination infused within all the players in those eco-systems across all the different types of reliability policy instruments would be incredibly important for the grid of the future, thank you.

MR. VANDERBERG: Thank you Devin. We'll go to Alison and then Richard.

MS. SILVERSTEIN: Thank you. I wanted to build on what Devin was saying in a different way. One of the things he was saying was we need planning methods to be consistent, and we need them to be improved. And as you've hard me say I think that needs to start with benefits, methods and metrics identification. And I encourage FERC to start working with the Department of Energy and its components to start thinking about some of the elements I suggested for the scope of a national electric transmission authority and what it might do to improve broadly planning methods, benefits, calculations et cetera.

The second thing is again that stuff is going to happen. I reframed that from the classic framing. Stuff is going to happen on the grid, and it's going to fail big. It's going to fail small. It's going to fail for a number of reasons, including climate change and normal weather variability.

And so, as well as gas cyberthreats and a whole lot of other stuff that we keep thinking should be worse than it is, and I'm surprised that we haven't had cyber take down the entire grid already. So I think that I beg you to invest hard and push hard all of the no regrets insurance and mitigation measures because we need stuff that's going to pay off every single day against every single threat, not just the mitigation measures that are big expensive hardening one off's.

We probably need some of them, and I'm sure they'll be cost-effective against whatever it is, but there's so many other things that you can do to keep us safe every single day, and that are going to pay off with bill savings and job creation, and people's lives. And we shouldn't have to wait for big heroic measures to get those kinds of benefits. Thank you.

MR. VANDERBERG: Thank you Alison. Richard?

MR. TABORS: Okay. Two points I guess. One is that I'll follow-up on something Judith said which is that we're not using information that's available very effectively, and I think the example I would use is that we work with IBM the weather company where we get 4 kilometer by 4 kilometer grid weather forecasting information off of what we use about 20 variables for forecasting, both wind and solar.

So there's just a tremendous amount of information there that's available that generally speaking is not being used in a coordinated fashion. And the second is that essentially I think we really need to work and develop better use of scenarios, and I use a terrible example from years ago when I was working with colleagues on oil forecasting, and that was you know forecasting oil prices, looking at what happened historically.

And in our case, forecasting anything historical is a little bit like driving down Pike's Peak looking only in your rearview mirror. It just doesn't work very well. So thank you for allowing me to be part of this today.

MR. VANDERBERG: All right. Thank you Richard. And 5:45 turning to Eric to take us home, thank you Eric.

MR. HEINLE: Okay. Thank you Eric and I'll be quick and leave everybody with just two thoughts. First, again let's look to least cost options first, you know the nice benefit of them is they are often also the quickest to implement. Whether something like an improved gas electric coordination, which certainly I think can help benefit things like potential gas generation outages is broad as that is it's probably easier to do that than to build a bunch of new pipelines and a bunch of new gas storage.

Looking at as other panelists have mentioned. Making sure we're using all the information that we have, all the data we have to informed RTO and utility operations so that they are best prepared to mitigate these. And not suggesting that information and coordination alone will solve all of our problems, but before we go the next step, and you know and put iron in the ground let's make sure we're taking advantage of what we have on the system and using it as offensively as possible.

And then the last point is please keep the consumer involved. Again, I really appreciate the opportunity to participate in today's panel. Consumers like being at the table. We have a lot to add, and keep involved not just sort of in the planning and the discussion and the modeling, but keep us involved in helping mitigate these issues through consumer side tools like demand response, DERs, all the sorts of behind the meter things.

Make sure those are incentivized correctly. Make sure the barriers are reduced, so that consumers can you know, participate. Ultimately consumers bear the costs for everything whether it's you know new investments, or the cost of an outage, and so consumers really should be at the center of solving all these issues as well, so thank you again.

MR. VANDERBERG: Thank you Eric and thank you to everybody. That brings us to the end of our time today. I just want to one more time say to all of our panelists for participating, we had an excellent discussion. It was incredibly information and so I want to again thank you for taking time out of your busy days to join us for this very helpful technical conference.

So with that thank you to everybody and we will reconvene tomorrow afternoon for the next set of panels. Thank you.

(Whereupon the technical conference adjourned at 5:47 p.m. to reconvene the next day at 1:00 p.m.)

CERTIFICATE OF OFFICIAL REPORTER

This is to certify that the attached proceeding before the FEDERAL ENERGY REGULATORY COMMISSION in the Matter of:

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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.

Gaynell Catherine

Official Reporter