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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.

1 Welcome and Opening Remarks

2

3 Introductory Presentation - More Frequent and Expensive

4 Extreme Weather Events

5 Adam Smith, Applied Climatologist, National Oceanic and

6 Atmospheric Administration

7

8 Panel 1: Planning for a Future that Diverges from

9 Historical Trends.

10 Romany Webb, Associate Research Scholar/Senior Fellow at the

11 Sabin Center for Climate Change Law, Columbia University Law

12 School

13 Derek Stenclik, President, Telos Energy, Inc.

14 Susanne DesRoches, Deputy Director of Infrastructure and

15 Energy, New York City Mayor's Offices of Resiliency and

16 Sustainability.

17 Lisa Barton, Executive Vice President/Chief Operating

18 Officer, American Electric Power

19 Judy Chang, Undersecretary of Energy, Massachusetts

20 Jessica Hogle, Federal Affairs/Chief Sustainability Officer,

21 Pacific Gas and Electric Corporation

22 David Easterling, Ph.D., Director, National Climate

23 Assessment Technical Support Unit NOAA's National Centers

24 for Environmental Information.

25

1 Panel 2: Best Practices for Long-Term Planning  
2 Assessing and Mitigating the Risk of Climate Change and  
3 Extreme Weather Events  
4  
5 Judith Curry, President, Climate Forecast Applications  
6 Network  
7 Neal Millar, Vice President Transmission Planning and  
8 Infrastructure Development at the California ISO  
9 Mark Lauby, Senior Vice President/Chief Engineer, NERC  
10 Devin Hartman, Director of Energy and Environmental Police,  
11 R Street Institute  
12 Alison Silverstein, Independent Consultant, Alison  
13 Silverstein Consulting  
14 Richard Tabors, President. Tabors Caramanis Rudkevich  
15 Frederick Heinle, Assistant People's Counsel, Office of the  
16 People's Counsel for the District of Columbia.  
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1 P R O C E E D I N G S

2 (1:00 p.m.)

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

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

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

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

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

8   Welcome and Opening Remarks

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

11                  MR. AMERKHAIL:  Yes.

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

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

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

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

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

25           Sometimes it's a loss worse than that as we saw

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

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

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

24 MR. AMERKHAIL: Thank you Mr. Chairman. I  
25 believe Commissioners Clements and Christie also want to say

1 a few words. Let's start with Commissioner Clements please.

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

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

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

22 It's important for me to remember that our job is  
23 not to halt progress towards a cheaper, more flexible and  
24 more resilient electricity system, but to protect customers  
25 and ensure reliability along the way. Success requires



1 smart planning operations and reliability regimes that  
2 embrace this reality of extreme weather risk.

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

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

14 Introductory Presentation - More Frequent and Expensive  
15 Extreme Weather Events

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

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

1 Smith?

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

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

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

25 So NOAA's National Centers for Environmental

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

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

14           And you can see how that has increased to in fact  
15 a bit more than 85 percent of the full distribution from  
16 1980 through 2020. 1.9 of 2.2 trillion dollars in total  
17 direct losses. And certainly, over the last several years  
18 the wildfires out west and the hurricanes in the Gulf and  
19 the Atlantic states have further skewed this distribution,  
20 but we'll get into that further. Next slide please.

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

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

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

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

25           And so you can see there's a lot of variability

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

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

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

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

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

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

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

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

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

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

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

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

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

21 So here are different ways to look at the data.  
22 Now this is a cumulative aggregate of the frequency of these  
23 billion dollar disaster events, each of the last 41 years.  
24 The black line is again the 41 year inflation adjusted  
25 average number of events per year. I should say that all

1 the dollar figures in this plot today are inflationary  
2 adjusted to present day dollars.

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

10           The 41 year inflation adjusted cost averages 46.5  
11 billion, and the black line again you see the red line is  
12 2020, it was in fourth place just behind 2012, 2005 and of  
13 course 2017 when we had Harvey, Irma, and Maria in addition  
14 to western wildfires. Those costs were in excessive of 300  
15 billion.

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

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

25           All right one more slide. So here over the last



1 41 years from January 1980 through March 2020, we've had 291  
2 separate billion dollar weather or climate related events.  
3 And so, the cumulative costs you could see at the bottom is  
4 1.9 trillion. So what I have circled here are a few  
5 takeaways.

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

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

20           Unfortunately, this year is looking like another  
21 challenging wildfire year. So wildfire costs are increasing  
22 proportionately the fastest. Next slide please, back one  
23 please, yes. So this is the same data except its  
24 partitioned by decade. What I have circled is the 2010  
25 decade and you can see the large jump over the 2000's decade

1 from 63 billion dollar disasters to basically doubled to  
2 123.

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

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

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

25 Tropical cyclones really from Texas to New

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

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

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

23 But this slide is more telling because it's  
24 looking at the cumulative cost frequency over the last 41  
25 years. Again, Texas leads the way about 300 billion dollars

1 in total direct losses, and it gets all the hazards that we  
2 focus on. Florida would be second at about 240 billion,  
3 most of those are hurricane impacts that you would expect.

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

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

22 But you can look at this tool in a variety of  
23 ways. We're just scratching the surface with this  
24 presentation, but I think this is a valuable metric we look  
25 at. One more slide please. And this is just a snapshot

1 showing that these extremes of course are seasonal.

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

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

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

25 And finally, I'd like to highlight what was noted

1 in the fourth national climate assessment a few years back,  
2 "The physical and socioeconomic impacts of compound extreme  
3 events such as simultaneous heat and drought, wildfires  
4 associated with hot and dry conditions or flooding  
5 associated with hot or high precipitation on top of a water  
6 logged ground, the impacts are greater than the sum of its  
7 parts."

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

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

17 Before I turn it over to our moderators for Panel  
18 1, I see that Commissioner Christie has arrived.  
19 Commissioner Christie would you like to make any opening  
20 remarks?

21 COMMISSIONER CHRISTIE: Thanks Rahim, and I would  
22 just say I've been having technical issues and not fully  
23 resolved yet, so I will not say much. But I want to thank  
24 all the panelists that put a lot of work into this. And I  
25 want to thank all the staff that put a lot of work into

1 this, and with that I will sign off and listen and hopefully  
2 get my technical issues resolved before too long, so thank  
3 you very much.

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

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

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

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

24 We will be foregoing opening remarks for this  
25 panel, and will move directly into a question and answer

1 session. If a panelist would like to answer a question,  
2 please use Webex raise hand function. Alternatively, if you  
3 are having any issues with the raise hand function, please  
4 turn on your microphone and indicate that you would like to  
5 respond.

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

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

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

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



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

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

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

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

25           And I think for all the system planners out

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

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

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

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

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

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

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

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

1 be able to respond to these?

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

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

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

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

25           MS. CHANG: Great. Thank you. First all thank

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

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

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

22           But also the simultaneous impact of changes in  
23 weather related events like climate related events, and how  
24 they affect both load and the usage of these renewable  
25 generation was significantly will be different, much, much

1 more in the future than it is in the past.

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

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

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

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

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

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

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

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

1 it was only factoring in voltage collapse and thermal  
2 violations.

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

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

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

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



1 I think you're the next speaker.

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

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

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

22 In New York State and New York City we have a  
23 number of different climate changes efforts that will be  
24 ongoing, but we do benefit from having a consistent set of  
25 projections. And again those can be successfully embedded

1 into the distribution network planning, as well at the NYISO  
2 level, and we can talk about that more later.

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

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

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

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

25 Of course utilities and system operators have a

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

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

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

24           So integrating those adjustments into the  
25 existing planning processes. And also thinking about new

1 specialized planning processes that are more -- are better  
2 suited to dealing with climate change along the lines of a  
3 colleague from PG&E described. That sort of more specific  
4 climate resilience planning will be very important.

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

7 MS. BARTON: No. Sorry about that.

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

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

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

1 risks.

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

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

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

22           And so, they are not all built to 2021 standards.  
23 Some are billed to 2030 standards. How will they do in  
24 different climate scenarios? So it's really taking a  
25 probabilistic view. What you would also do I think at the

1 next level is take a look at similar questions at a regional  
2 level, again.

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

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

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

21           And so thinking about redundant black start  
22 paths, making sure that our black start generation is the  
23 most resilient of our generation, while asking ourselves the  
24 question is load shift an acceptable tool? It has always  
25 been an acceptable tool in the past. Will it continue to

1 be? And then thirdly as you go to the interregional view, I  
2 think that it's really important to -- and we learned this  
3 from Storm Uri as well.

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

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

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

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

1 some of these risks, the transmission is a key reliability  
2 contributor.

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

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

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

23 Ultimately, when we think about reliability as an  
24 industry we need to rather jog about cohesive regional  
25 planning, or full interconnection planning to make sure that



1 we're fully leveraging that capability for reliability.

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

5 MS. HOGLE: Sure. I want to build on what Lisa  
6 and Derek said too and comments we heard earlier because I  
7 don't want to underscore how important you know I think it  
8 was Susanne that said that consistency of data that you're  
9 using right? In California you know we're using the RCP  
10 8.5, and we're also using the California climate assessment  
11 data.

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

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

1 solar output that you had.

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

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

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

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

25           For the NCA-4 we used the couple modeled with our

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

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

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

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

1 this is the annual temperature change.

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

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

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

23           You can actually see the Rocky Mountains, and to  
24 a lesser extent the Appalachian Mountains and in the  
25 mountains in Mexico where you can see this is the change of

1 the number of days over 90 degrees at the end of the  
2 century. And it's quite large in terms of the scenarios.  
3 So we produced these for the use by the authors and national  
4 climate assessment, you know, we feel like they're sort of  
5 state of the art, probably the best that people can use  
6 right now.

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

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

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

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

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

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

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

22           MS. DESROCHES: Sure thanks. So in New York City  
23 we have down sampled climate projections through an academic  
24 body called the New York City Panel on Climate Change. But  
25 it provides very similar information to what David was just

1 showing, so days over 90 degrees, sea level rise projections  
2 in a range of RCPs et cetera.

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

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

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

24           Those really super, super cold days. They last  
25 you know sometimes a week. We have to plan for that as well

1 as you know a three or four times the amount of days over 90  
2 degrees, at least that's where we'll be in New York City.  
3 So again, we have a long history of using this kind of data.  
4 Not just in the electric sector, in transportation and  
5 otherwise to do successful adaptation planning.

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

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

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

22 So I just think there just needs to be better  
23 linking of the power system planning codes to have more of a  
24 background in meteorology and climate, and vice-versa with  
25 the climate community to have a little bit more background



1 in the power system operations. That's going to be  
2 critical.

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

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

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

22 And then also on the load side I think FERC 714,  
23 or FERC form 714 is kind of the go to source for the load  
24 data if you're going to do a large regional or national  
25 study, and I think that can also be improved, have more

1 insight on weather conditions and distributed generation and  
2 likewise.

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

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

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

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

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

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

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

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

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

1 saying earlier, this is very complex.

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

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

15           We may not in the future want to place  
16 transmission lines along the same corridor. We may need  
17 more diversity in the future. The most important thing I  
18 think to think about looking into the future as far as load  
19 forecast is the assets we build today are meant to last 40,  
20 50, 70 and maybe even 100 years long, so the climate  
21 forecast is not just for the next year or 10 years, we have  
22 to think about when we make these investments you know  
23 multi-billion dollar investments, what they're going to look  
24 like 70 years from now because most of them will actually  
25 still be there, or parts of them will still be there.

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

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

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

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

25           MS. HOGLE: Sure. I just wanted to raise on you

1 know kind of the availability of data. David asked the  
2 question at the end is this helpful, and I think the answer  
3 is always yes right? Availability of data is critically  
4 important and it's always helpful. I know for us at PGE  
5 we're very fortunate that California has invested in you  
6 know providing this data.

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

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

23           You know as I think Lisa mentioned is more and  
24 more sectors become dependent on the grid it's critical that  
25 we have this, but we also have to understand that we're only

1 as resilient as we all are together, and so I just think the  
2 more we can provide data, and the more you know FERC and for  
3 us in California we're seeing the CPUC do this you know kind  
4 of providing a blueprint as to how we may do things, and  
5 being transparent about it.

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

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

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

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

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

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

14           And they are not absolutely 100 percent certain.  
15 But to Undersecretary Chang's point, you know utilities and  
16 system operators and others are making investments in  
17 long-lived assets, many of which may still be around in  
18 2050. So the fact that these projections are far into the  
19 future, doesn't undermine their usefulness, and that if  
20 anything it actually increases their usefulness as a sort of  
21 input into the decision-making tool.

22           And not only does factoring those forward-looking  
23 projections into those investment decisions sort of help to  
24 design more resilient infrastructure and sort of build in  
25 resilience so that we can avoid the need for future



1 retrofits or hardening, it also has other financial benefits  
2 you know we're seeing increasing concern within the  
3 financial and the insurance communities about future climate  
4 risk.

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

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

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

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

25           Now it doesn't have the vulnerability of the

1 existing system, and I think that that is something that we  
2 really have very little understanding of when those towers  
3 were built, when those underground cables were installed,  
4 how vulnerable are they now to climate change? And how much  
5 does that vulnerability increase over time?

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

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

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

1 vulnerabilities today, and as they project out in the  
2 future.

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

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

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

24 I think this needs to happen at least at a  
25 regional level, which I know is very complicated and

1 difficult to do. Certainly across the different regulatory  
2 entities that construct that we have, but there needs to be  
3 that kind of guidance so that people can start today and not  
4 you know wait until that planning process is perfected in  
5 order to start integrating climate change thank you.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

18           MR. AGBEDIA: Thank you Louise. The next  
19 question we've already discussed a lot of it, so just a  
20 little segue into it. The question is Are there best  
21 practices for developing probabilistic and stochastic  
22 methods for estimating these typical planning inputs,  
23 including through the use of expert developed climate  
24 scenarios such as the Representative Concentration Pathway  
25 scenarios for baseline CO2 projects developed by the

1 intergovernmental panel on climate change? I'll direct this  
2 question to Doctor Easterling.

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

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

19 Or is it going to be sort of the business as  
20 usual which is the 8.5 where we have emissions just  
21 continuing out to the end of the 21st Century which is very  
22 sort of risk-based planning, but is that realistic you know?  
23 My expectation or hope is that we're going to be closer to  
24 4.5, but I may be wrong. But what you do is you can get you  
25 know an idea of uncertainty by using the fact that even LOCA

1 has you know you don't get just one time series of  
2 temperature. You know you get a number of like 30 times  
3 series because you used a number of different models in  
4 there.

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

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

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

24           MS. HOGLE: Thanks. I mean I think that one  
25 thing is a kind of shared understanding and discussion



1 around risk tolerance, and I think I mentioned that earlier.  
2 The California Public Utilities Commission has directed us  
3 to use the RCP 8.5 pathway, and so in our analysis and so  
4 you know we have that kind of benchmark, and that's the data  
5 that we're incorporating into our decision-making.

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

13           You know that's where you get into that risk  
14 tolerance, what it is that you want to plan for. And then  
15 also on an annual basis incorporating the results of your  
16 current vulnerability assessment into your -- you know the  
17 annual asset management plans that we do, and then of course  
18 before you put something in the ground you're going to want  
19 to make sure that it's going to be built to withstand the  
20 40, 50, 60 year lifespan, but utility assets typically  
21 enjoy.

22           And then we also you know seek to incorporate the  
23 results of our analysis in our risk models, so we understand  
24 what kind of the overall vulnerability is but then we need  
25 to incorporate this into the risk models to then understand

1 what the impacts and the consequences are, you know what's  
2 the impact to the risks in terms of frequency, and then what  
3 are the consequences from a customer perspective if these  
4 were to materialize?

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

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

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

24           So I think that's something that needs to be done  
25 you know beyond we're already doing these in California, but

1 it will be helpful to expand upon that on the regional level  
2 which I think a lot of my colleagues have already kind of  
3 mentioned.

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

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

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

22 So I think David, you've brought up the tool that  
23 you all are working on that would let you go in and kind of  
24 develop a scenario using the larger dataset, the larger  
25 modeling tools that you already have available. I think

1 tools like that are critical because you know somebody  
2 brought up before, and David maybe it's you, about how a  
3 small utility, or a small entity or developer might not have  
4 the funding to go do a full climate study.

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

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

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

25 MS. NUTTER: Thank you very much. Undersecretary

1 Chang I see you raised your hand.

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

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

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

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

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

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

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

3 MS. NUTTER: Yes you will one second.

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

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

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

24 It's of course using site specific questions and  
25 location information and provides specific projects, a

1 preliminary climate risk rating and recommendation, and how  
2 to increase the resiliency of project design through  
3 targeted planning horizon return periods, design criteria  
4 and methodologies for utilizing state-wide climate data.

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

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

23           And then the next slide please. It will give you  
24 -- I know it's very hard to see, and I don't mean for you to  
25 read everything, but the idea here is it gives an output



1 about the climate related risks associated with certain  
2 infrastructure investment, or it could be a building, it  
3 could be a bridge, it could be anything that's you know  
4 comparable investments.

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

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

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

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

23           DR. EASTERLING: Sure. So I just want to mention  
24 so how to arrive at the extremes came up a little bit  
25 earlier, and so we've heard in NOAA atlas 14, that's the

1 atlas that we produce that is used by civil engineers to  
2 look at okay, a design to the 100 year 24 hour landfall  
3 amount, or something like that.

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

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

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

1           So you know our current 24 hour 100 year rainfall  
2 event in the future it may be six inches now, it may be 8  
3 1/2 or 9 inches in the future for a given location. So we  
4 actually have produced this, and we now are about to put out  
5 where you could actually go in and it will bring up you know  
6 our map, and it says okay, I want to look at New York City.

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

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

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

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

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

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

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

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

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

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

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

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

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

9           MS. NUTTER: Yes.

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

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

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

1 changed.

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

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

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

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

23           Specifically around how methodologies should be  
24 rethought around resource adequacy planning. A lot of that  
25 is you know certainly better accounting of the underlying

1 weather, needing to evaluate a full year of the operation,  
2 not just our conventional peak load periods, so I think  
3 that's a really big takeaway that is also very applicable in  
4 the climate context.

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

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

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

1 future?

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

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

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

18           COMMISSIONER CLEMENTS: Great.

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

22           MS. BARTON: Thank you. So first and foremost I  
23 do want to say I agree with everything that Derek just said.  
24 Getting resource adequacy right, looking at it differently,  
25 looking at how resource adequacy can be bolstered by



1 companies with generation at the other side of the scenes is  
2 really, really important for us to start to consider.

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

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

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

25           If my determination of need is different a

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

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

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

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

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

23           MS. WEBB: Yeah thank you. I agree with the  
24 previous two panelists in that we need to supplement the  
25 existing sort of planning approach, particularly the

1 resource adequacy planning approach with this more climate  
2 specific form of planning.

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

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

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

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

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

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

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

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

19          We're thinking about planning in a proactive way.  
20   I can't emphasize the importance of that.   I think we have  
21   to plan in a proactive way.   I don't think New England has  
22   done that yet, so we do need to look at scenarios, even  
23   without climate risks, we need to take a scenario-based  
24   proactive way to plan the system, whether it's resource  
25   adequacy or transmission planning, and I do agree with

1 previous panelists it will be best if we can use consistent  
2 set of data, internally consistent set of data, so that  
3 we're not using you know a summer in a different year with a  
4 different winter and the hydro is not consistent with the  
5 solar and the wind.

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

10 And then I think in addition to scenario-based  
11 which is the deterministic approach, we also do need to  
12 think about the tail end of that distribution, or sort of  
13 that 1 in 10, 1 in 100 risk, and really ask ourselves how --  
14 this is not just like billed to that 100, 1 in 10 or 1 in  
15 100, but really ask ourselves the potential costs of those  
16 extreme events and compare to what kind of investments we  
17 might need to prevent or at least mitigate, those extreme  
18 events.

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

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

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

10          MS. HOGLE: Yeah I agree with what everyone else  
11 has said. I think the only thing I would just add here is  
12 on the transmission side, you know obviously resource  
13 planning and transmission are inextricably linked, and so  
14 you know kind of the typical outlook or planning process of  
15 10 years could be constraining.

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

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

1 Miss Barton?

2 MS. BARTON: Okay sorry.

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

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

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

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

25 MS. BARTON: Sure. I mean one of the ways that

1 you can do it is you can sit there and say that you want to  
2 from a resource adequacy standpoint, be able to rely on X  
3 percent from a neighboring region. I mean in the end you  
4 would actually be building less you would be saving more  
5 money.

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

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

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

24           Because right now you know I've been in this  
25 industry for decades upon decades it seems. And I've been



1 talking a lot about transmission planning, and I've been  
2 talking a lot about interregional planning, and yet there  
3 really has never been interregional planning.

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

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

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

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

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

3           COMMISSIONER CLEMENTS: Thank you. Thanks  
4   Louise.

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

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

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

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

24          MR. STENCLIK: Yeah I have one last thing to add  
25   on the transmission. It's really thinking about

1 transmission more as a reliability resource or as a capacity  
2 resource. I think traditional transmission planning, we  
3 often fall into the trough of just evaluating a transmission  
4 project based on the production cost benefits or to relieve  
5 the congestion, and we fall short of really looking at other  
6 value stacking, predominantly probably the largest one there  
7 being the ability to look at transmission as a capacity  
8 resource in bringing in the reliability benefits.

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

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

21           But using the reliance of neighboring systems and  
22 making sure that when you do the resource adequacy analysis  
23 you do a full system, or full interregional analysis that  
24 doesn't simplify the assumption of okay, how much can we  
25 lean on our neighbors, but look at the neighboring utilities

1 and neighboring ISOs in the same probabilistic manner that  
2 you're evaluating your own system with. I think that's  
3 critical as well.

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

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

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

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

1 solutions -- both at the asset level, but also at the  
2 systems level.

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

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

22 And to what level? So that makes it complicated,  
23 but then can that be upgraded over time? Do we have to  
24 build today for 2100 projections that are at the very high  
25 end, or is there a way to do sort of interim level

1 adaptation that are flexible enough, or technologies that we  
2 assume will come that we can install in the second half of  
3 the century to make those assets stronger.

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

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

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

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

21 Often when we focus on sort of traditional or  
22 legacy approaches like investments in the capacity or asset  
23 hardening, but there's a whole load of other things that can  
24 be done as was said building in that resilience up front,  
25 looking at customer oriented, or customer focused resilience

1 measures, the distributed storage, demand response et  
2 cetera.

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

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

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

25           It can be difficult to identify and accurately

1 quantify some of the benefits of those measures in part  
2 because they depend on future outcomes, future climate  
3 outcomes which aren't 100 percent certain.

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

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

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

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

24           MS. HOGLE: Thanks. I just wanted to provide an  
25 example of you know utilizing new tools and ways to evaluate



1 these investments, but before I do so I just want to say you  
2 know the question in and of itself in some ways has a bit of  
3 a false premise because we know that you know planning and  
4 making these investments early is less expensive for our  
5 customers, than having the event occur and then having to  
6 rebuild and respond after the fact.

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

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

1 gas or diesel when necessary.

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

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

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

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

21 That's how we design our primary serve margin,  
22 and fundamentally how we procure resources to meet our  
23 reliability requirements. And fundamentally with the  
24 changing resource mix with climate change, a loss of load  
25 expectation is not going to cut it in the future because it

1 only measures the frequency of events occurring, it does not  
2 measure the size or magnitude, or duration of the events.

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

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

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

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

24           And really making sure that we go beyond just  
25 looking at average values, or average risk assessments, and

1 looking at a full distribution of potential outcomes so that  
2 we can take into account how bad with that worst case about  
3 being and is it worth addressing some of the larger outlier  
4 events, especially if there's a low cost solution for them.

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

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

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

22 What might happen if you were to have you know a  
23 severe event that's going on in the system? You want to  
24 make sure that you have that ability to restart the grid if  
25 you ever need it. We've never been as close quite frankly,

1 to losing an interconnect as we were with Texas just a few  
2 short months ago, and despite the weatherization you know, a  
3 lot of the things that the state is actually working on.  
4 That still remains a significant risk.

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

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

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

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

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

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

18           MR. STENCLIK: Yeah I guess the first thing is  
19 just to start pushing forward best practices and ways and  
20 methods that should be included. I think one of the  
21 approaches that we're taking with redefining resource  
22 adequacy is setting up a set of first principles that we're  
23 then trying to disseminate, and when we work with  
24 stakeholders in different regions, different ISOs,  
25 different utilities, it is trying to develop a framework

1 recognizing that each region is going to have its own  
2 regulatory structure, it's own resource mix, its own unique  
3 approach that they need to take for resource adequacy, but  
4 what are some of the first principles that apply really  
5 across the board and set up the best practices that could be  
6 applied.

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

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

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

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

25 MS. NUTTER: Miss Chang your hand is raised. Did

1 you have something?

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

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

18 And I think that would be an important starting  
19 point.

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

23 MR. AGBEDIA: Thanks Louise. Thank you very much  
24 everyone for that discussion. We've reached the end of our  
25 time for this panel. So I'll conclude by thanking our



1 panelists again. We appreciate your participation. We will  
2 now take a 20 minute break and we'll reconvene at 3:45 p.m.  
3 Panel 1 speakers you may sign out of the Webex, and if you  
4 would like to continue the conference you can use the public  
5 web link that was sent to you, or you can visit at [ferc.gov](http://ferc.gov).

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

10 (Break)

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

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

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

1 extreme weather and developing cost effective mitigation.

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

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

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

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

22 Welcome to this esteemed set of panelists. We  
23 really appreciate you joining us today. Before we get into  
24 our question and answer session I'd like to remind everybody  
25 again to refrain from discussion of any pending contested

1 proceedings. If anyone does engage in those kinds of  
2 discussion, my colleague, Michael Haddad from the Office of  
3 General Counsel will interrupt the discussion with a gentle  
4 reminder to avoid that topic.

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

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

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

21           Where I'd like to dive in is a little bit where  
22 the last panel left off. I thought there was a lot of  
23 really good discussion on the last panel about you know the  
24 distinction between some of the climate change impacts like  
25 sea level rise, rising temperatures, and extreme weather

1 events, you know the things in the former category, those  
2 are things that will occur more gradually over time.

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

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

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

23           (Audio glitch) we provide regional scenarios of  
24 future extreme weather events including event frequency and  
25 the severity of the worst case. These scenarios are based

1 on natural multi-decadal climate variability, as well as  
2 manmade global warming. I don't rely on (audio glitch)  
3 since the climate models provide a range of weather outcomes  
4 that is too narrow.

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

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

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

22 Response protocols are developed, and then  
23 deployed operationally in a (audio glitch). Such  
24 strategies support robust decision-making and can result in  
25 better outcomes with less damage and more rapid restoration

1 of services. Here's an example. Since 2013 my company CFAN  
2 has been (audio glitch). -- impacted by hurricanes.  
3 Reconstructive landfalling winds from historical hurricanes  
4 are used to draw their outage models to produce a range of  
5 possible outage scenarios.

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

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

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

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

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

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

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

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

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

1 plus reliability services, plus flexibility of ramping.

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

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

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

21           Now we're talking about extended cold weather,  
22 extended hot weather, weather, wind droughts, solar  
23 droughts, and we have to build those into our framework, and  
24 of course we don't have a lot of experience looking back, so  
25 we have to see what's possible going forward so we build a



1 system that not only provides the energy along with the  
2 capacity energy and ramping and reliability of services, but  
3 then ensures that they are there during the more severe long  
4 duration events.

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

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

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

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

19           And I think the existing deficiencies that we see  
20 in many ways from which climate risks in the existing  
21 reliability policy, and we look at the ways that climate  
22 change manifests itself in that risk profile. We really  
23 need to recognize that as a previous speaker said there's a  
24 lot of work we can do on just a no regret approach. And I  
25 think that's really important to emphasize because I think

1 climate risks largely exacerbate a lot of the existing risk  
2 factors that this industry ostensibly already incorporates  
3 to some degree.

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

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

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

1 uncertainty.

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

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

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

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

25           MS. SILVERSTEIN: Thank you and good afternoon.

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

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

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

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

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

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

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

22           And last I concur with many of the past panelists  
23 that when we talk about cost benefit analysis we far too  
24 often talk about and assume that what matters is the cost of  
25 the measures that we are considering taking, rather than

1 comparing not just those measures against each other, but  
2 more critically what are the consequences and costs to us if  
3 we don't take these measures?

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

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

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

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

25           So there's a lot going on, and I think that the

1 fact that the industry still references an engineering  
2 driven reliability standard of 1 day in 10 years is somewhat  
3 close to unbelievable. That standard of LOLE doesn't  
4 consider the economic consequences of service interruptions,  
5 the fact -- and that fact is compounded by the assumption of  
6 unit outage independence, and a failure really to reflect  
7 weather trends.

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

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

22           The result is that from my perspective on kind of  
23 answering your question, we have to really understand that  
24 there are probability distributions out there that we're  
25 simply not paying attention to and that fit nicely into the

1 mindset of the utility industry, but we've got to get them  
2 into that mindset, not kind of ignore the fact that we know  
3 a lot more and are able to do a lot more analysis now, than  
4 has been the case in the past, so I'll stop thank you.

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

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

8 MR. VANDERBERG: Yes we can.

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

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

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



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

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

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

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

25           MR. VANDERBERG: Very good thank you Eric. I

1 appreciate it. A lot of good comments to get us started.  
2 Hard to pick where to start first but what I'm going to do  
3 is start off with a session of something that's come up a  
4 couple of times here and in the prior panel which is  
5 capacity.

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

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

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

21           MS. SILVERSTEIN: All those years of playing hit  
22 the button faster paying off thank you. Yes 1 in 10 is  
23 completely outmoded, and it's generation centric and ignores  
24 all of the other capabilities out there including demand  
25 response, including the fact that we can actually enlist

1 customers to control their demand and manage it in better  
2 ways, and it ignores a lot of the other capabilities out  
3 there.

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

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

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

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

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

1 and energy efficiency to meet the capacity?

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

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

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

1 MR. VANDERBERG: Thanks Eric. Devin?

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

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

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

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

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

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

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

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

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

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

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

22           How much ramping are you going to need? What are  
23 the reliability of services you're going to need? And back  
24 out of that what one day or whatever means. Because  
25 remember at that time you didn't have computer space, you

1 only had 1 event in 10 because that's all you could model in  
2 the 1960's on an IBM 360. So obviously now we can do hours  
3 and hours and hours of calculations.

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

12 And to see how that warrants the difference in  
13 energy requirements and flexibility requirements and likely  
14 service requirements and then figure out what the 1 in  
15 whatever is. Again, it used to be cool because you get your  
16 1 in 10, you figure out the dog gone reserve margins.

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

20 MR. VANDERBERG: And Neal?

21 MR. MILLAR: Thank you. So when I hear the  
22 discussion around the 1 in 10 it sounds like at one extreme  
23 some people are still thinking of it in the context of the  
24 way it was calculated 20-30 years ago. And I admit the way  
25 I calculated it 30 years ago. But in jurisdictions like



1 ours there's a high penetration of renewable resources,  
2 we've had to look even in that probabilistic calculation  
3 around what's actually going to serve the load each hour of  
4 the day, and what kind of within some reasonable framework  
5 of outages, what's your probability around being able to  
6 supply load, but you have to be looking at 8760.

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

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

21           But then also scenario analysis and assessment  
22 that have to consider the boundary conditions and  
23 effectiveness. And a lot of that really has to come in the  
24 longer term resource planning considerations, not just  
25 taking whatever falls out the bottom of a model per se, well

1 that's your most economic generation mix, but then you have  
2 to test your scenarios.

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

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

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

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

25           MR. TABORS: Thanks. Let me pick up a little bit

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

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

23           In other words there's a sense of price driven  
24 response, so to me there's an effort at this stage to  
25 getting away from the one day in 10 years which I think by

1 the way calculate what that is in economic terms. It's a  
2 rather shocking value that we assume consumers are willing  
3 to pay, but ignoring that for the moment, looking at it and  
4 saying okay let's get the resource adequacy process into a  
5 much more efficient and routine and dynamic process of  
6 calculation of probability of there being a problem if you  
7 were.

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

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

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

21           MR. VANDERBERG: Absolutely Alison.

22           MS. SILVERSTEIN: Thank you. The basic premise  
23 of 1 in 10 and designing to that has always been if I get  
24 this number right everything will be fine. And then the  
25 only thing that matters is so you build to 1 in 10 because

1 that's what the standards allow, and then you sit back and  
2 essentially assume everything's going to be good.

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

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

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

23 Can you talk me through how you know an approach  
24 like that, or a more probabilistic approach addresses the  
25 issue of common mode failure? Once again I think one of the

1 challenges that we're seeing and we're not seeing resources  
2 linked in ways that we haven't thought about before  
3 previously. We've always kind of thought of resource  
4 outages as independent, now we're seeing them linked.

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

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

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

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

24           But even after you finish that you still have to  
25 look at some of these common mode failures. We've been

1 putting more time on looking at what the gas supply system,  
2 what redundancy is on the gas supply system into California.  
3 Given the shift in usage for parts of the system where the  
4 gas fired system is expected to operate much less than it  
5 did in the past, but much more urgently when called upon  
6 puts more pressure on the local gas storage fleet for what  
7 sort of gas storage capability do you have in certain  
8 areas.

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

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

25           So I think it's necessary to consider those kind

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

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

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



1 problems that we do have.

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

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

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

14           The combination of drought, high winds that go  
15 with it, thunder and lightening storms, lack of water, those  
16 all go together, and they all affect the power sector and  
17 with it the natural gas sector. And so one thing I'd like  
18 to flag because it's a FERC problem is that essentially the  
19 fact that the natural gas market runs on a time clock and a  
20 mindset that's incredibly different from the electric  
21 mindset and time clock in terms of the market that  
22 essentially there's just a desperate need to get  
23 information flow, to get data flow, between those two market  
24 structures if we expect to be able to use the natural gas,  
25 and we're going to have to in order to handle ramping and

1 other issues that are associated with the industry as the  
2 industry moves more into more renewable technologies.

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

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

19           MR. VANDERBERG: Thanks Richard. Mark?

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

1 operations.

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

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

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

25           One of course looking at them and lengthening the

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

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

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

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

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

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

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

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

23 You know is it going to be a record breaker, or  
24 whatever. So we really have some information, some weeks in  
25 advance, and so you know my question is what's the plan when

1 you see something like this coming? You know it seems like  
2 relying on the mix of you know, huge demand, no supply from  
3 the wind and the whole region is suffering the same  
4 conditions.

5 I mean what's the plan here.

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

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

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

20 And before we sort of leap to those types of  
21 costs upgrades, looking at something where we can better  
22 coordinate better manage the gas and electric markets so  
23 that you now we can get a better sense from delivery, get a  
24 better sense of what's available in the pipeline. Making  
25 sure that those gas resources that we count on for things

1 like capacity performance in the PJM region are available,  
2 and are able to perform, you know, that's really a bang for  
3 the buck for consumers and you know much more cost  
4 beneficial way of perhaps you know maybe it doesn't address  
5 every situation, but it does address a lot of potential you  
6 know resilience weaknesses.

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

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

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

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

22           MR. VANDERBERG: Absolutely.

23           MS. SILVERSTEIN: Well thank you. All of the --  
24 I agree with everything that the other panelists have said,  
25 and it highlights the many, many, many things that can go

1 wrong, and the degree to which grid reliability is teetering  
2 on more and more what ifs, and more and more preparations.

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

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

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

20           MR. LAUBY: And I wanted to mention that we need  
21 to engage industry in a broader conversation around what the  
22 design basis of the system of the future is really going to  
23 be. And this picks up on what Neal was talking about a  
24 little better over here. That you know it used to be the N  
25 minus one would be the transmission line or a generating



1 station or plant, and then extreme conditions were something  
2 you know, and now we're talking about common everyday  
3 so-called extreme events that takes out wide swaths of  
4 resources and so how do we then respond to that?

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

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

24           MR. VANDERBERG: Thank you Mark and that's  
25 actually a great segue into the next question that I was

1 going to tee up for this group which is about the current  
2 approach that we're taking to transmission planning, so I  
3 want to shift gears a little bit and talk about transmission  
4 planning. Mark as you were eluding to a minute ago, you  
5 know, the current approach that we have in the NERC  
6 standards in TPL1 is a deterministic approach.

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

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

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

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

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

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

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

25           I'm sorry the chances of building it from scratch

1 are real close to zero. Thanks.

2 MR. VANDERBERG: Thank you Devin?

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

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

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

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

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

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

23           A lot of times you see a massive amount of  
24 variance between the reliability performance within a single  
25 region right. We sort of have these chronic dead zones if

1 you will right. And there's reason that those dead zones  
2 have persisted for a long time now. We're not seeing  
3 customer valuation of reliability manifested in the planning  
4 process evenly across these spatial elements right.

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

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

15 MR. VANDERBERG: Thank you Devin. Alison?

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

24 And getting those to our greatest customer  
25 concentrations, and where electrification will have the

1 greatest impact requires more transmission. So more  
2 transmission is non-negotiable for the sake of achieving  
3 decarbonization. And as many of the panelists discussed on  
4 the last panel, for a reliability point of view transmission  
5 is an absolutely essential reliability tool and protector.

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

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

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

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

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

18           MR. VANDERBERG: Thank you Alison. Eric?

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



1 for more authority.

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

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

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

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

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

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

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

22           There are differences in the different areas and  
23 those need to be taken into account. California is a little  
24 unique where CALISO has about 80 percent to the state inside  
25 our footprint as well as the small portion of Nevada, so a

1 lot of people consider that to be a one state ISO. Within  
2 our region we believe our regional processes have been very  
3 effective.

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

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

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

1           We've gone through that process for 12 major  
2 projects that were put out for competitive procurement, and  
3 7 of those went to independents, and 2 to consortiums that  
4 included incumbents, but also included independents. So I  
5 think those processes have been quite successful.

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

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

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

1 the transmission owners.

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

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

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

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

24           COMMISSIONER CLEMENTS: Thanks Eric. I wanted to  
25 follow-up on Alison's proposal, appreciating everything that

1 got said from you know the demand side all the way up to  
2 making the current system more efficient. At some point to  
3 the need that Alison described if you accept her premise.

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

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

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

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

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

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

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

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

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

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

21           And so we could have been deeply out of luck had  
22 we not come back from the brink by dropping 25 gig of  
23 customer load. The consequence of the fundamental benefit  
24 of transmission is not merely that it is a supplement to  
25 capacity or a way to bring in energy or ramping when you



1 need it, it's that it creates this foundation of flexibility  
2 and optionality.

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

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

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

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

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

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

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

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

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

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

6           And so I think that Alison's idea is one idea to  
7 definitely address that institutional problem. And then on  
8 the benefit side part of it is to make sure that we're  
9 holistically including all categories of transmission  
10 benefits in the integrative process rather than the silo. I  
11 mentioned economic and reliability projects, but there's  
12 also the public policy objectives of the state that Order  
13 1000 acknowledges.

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

23           And so we really need to do a more integrated  
24 cost of some of the benefits, the valuation side which will  
25 really help the four regional. It's helpful with

1 interregional, but unless we address that fundamental  
2 institutional dilemma, I'm not sure how many strides we can  
3 make on that front.

4 MR. VANDERBERG: Great thank you Devin. Eric?

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

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

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

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

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

11           MR. VANDERBERG: Thank you Eric. Richard?

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

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

22           MR. VANDERBERG: Very good thank you Richard. I  
23 believe that is all the hand raises. So we have about a  
24 half hour left in our panel. Time is really flying, and so  
25 I want to make sure that the other Commissioners here have

1 an opportunity to ask questions as well, so I'll turn to  
2 Chairman Glick to see if he has any questions.

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

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

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

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

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

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

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

15           MS. SILVERSTEIN: Thank you. I need to support  
16 11 years of my professional career by reminding us that  
17 there's lots of synchrophasor data enabled analytical  
18 solutions that can be used to operate the grid more  
19 effectively.

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

1 transmission system. Thank you.

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

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

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

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

25 MS. SILVERSTEIN: One consideration is a long



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

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

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

1 these three sets of costs and consequences, and pick their  
2 poison.

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

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

20           CHAIRMAN GLICK: Thank you.

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

25           MR. MILLAR: Yes. And thank you for the chance

1 to comment on this. Obviously, like in California there's  
2 considerable emphasis on energy efficiency. Trying to  
3 capture demand response programs in a way they can  
4 effectively help, not only on a system-wide basis, but we  
5 also employ demand response programs in our local resource  
6 planning as well, so very heavy emphasis on those programs.

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

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

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

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

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

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

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

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

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

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

25           And then on the emergency side, what we really

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

22           MR. VANDERBERG: Thank you. At this time I'll  
23 just ask any other Commissioner questions? No. Okay. Well  
24 we are actually near the end of the panel. We have about 15  
25 minutes left, so one thing I would like to do as we look

1 towards closing would be just to go through all of our  
2 panelists and again, we have a couple of our Commissioners  
3 here today with us, and I know it's difficult, but I wanted  
4 to see if we can boil it down to one or two things that we  
5 should take away -- we being this Commission, as action  
6 items from this discussion.

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

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

22           In terms of what we understand about the climate  
23 system we're on much more comfortable ground going out 30  
24 years in the future, since we're talking about going out to  
25 2100 it's much more uncertain. So the extent that we can

1 take advantage of the greater confidence that we have in our  
2 understanding of how the next 30 years might play out, I  
3 think would be a useful focus because that's the lifetime of  
4 a lot of infrastructure, and certain things.

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

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

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

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

25 MR. MILLAR: Thank you. First, I'd just like to

1 reiterate and especially point to some of the comments made  
2 by panelists in the first session, that the climate change  
3 adaptation covers a whole range of activities from detailed  
4 engineering efforts around standards for construction and so  
5 forth, through transmission planning all the way to the  
6 longer term resource planning activities. So this isn't  
7 just a single topic, this is a whole spectrum.

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

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

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

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

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

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

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

1 affect an outcome.

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

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

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

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

25           MR. LAUBY: I have two points. One is of course

1 start looking again at planning in the three timeframes.  
2 And certainly, we're looking at long term as some of the  
3 bookends, consider in back in the day what happens if all  
4 nuclear plants have shut down? Look at what those kinds of  
5 scenarios look like so that you can make a plan around those  
6 and to a sensible resource mix that's going to deliver the  
7 energy, the reliability services, and the ramping that  
8 you're going to need.

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

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

22           We need to understand what those implications,  
23 are, how we mix the smart grids with the long distance  
24 transmission we're talking about and the energy efficiency  
25 and all that, how we tie that all in to be able to get to a

1 design basis that delivers the kind of reliability security  
2 resilience that we expect in the grid. Thank you.

3 MR. VANDERBERG: Thank you Mark. Devin?

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

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

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



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

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

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

22           The second thing is again that stuff is going to  
23 happen. I reframed that from the classic framing. Stuff is  
24 going to happen on the grid, and it's going to fail big.  
25 It's going to fail small. It's going to fail for a number

1 of reasons, including climate change and normal weather  
2 variability.

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

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

19           MR. VANDERBERG: Thank you Alison. Richard?

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

1 what we use about 20 variables for forecasting, both wind  
2 and solar.

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

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

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

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

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

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

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

25           MR. VANDERBERG: Thank you Eric and thank you to

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

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

10               (Whereupon the technical conference adjourned at  
11 5:47 p.m. to reconvene the next day at 1:00 p.m.)

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