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COMMITTEE HEARING

BEFORE THE

ENERGY RESOURCES CONSERVATION AND DEVELOPMENT

COMMISSION OF THE STATE OF CALIFORNIA

In the matter of,	)	
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	)	
2015 Integrated Energy Policy	)	
Report (2015 IEPR)	)	

CPUC/CEC WORKSHOP ON

CLIMATE ADAPTATION OPPORTUNITIES FOR THE ENERGY SECTOR

CALIFORNIA PUBLIC UTILITIES COMMISSION

CPUC AUDITORIUM

505 VAN NESS AVENUE

SAN FRANCISCO, CALIFORNIA

MONDAY, JULY 27, 2015

9:30 A.M.

Reported By:
Julie Link

APPEARANCES

Present on the Dais

Robert B. Weisenmiller, Chair, California Energy Commission

Karen Douglas, California Energy Commission

Liane Randolph, Commissioner, California Public Utilities Commission

Mike Florio, Commissioner, California Public Utilities Commission

Ken Alex, Senior Policy Advisor to Governor Brown and the Director of the Office of Planning and Research

CEC Staff Present

Alana Mathews, Public Adviser

CPUC Staff Present

Tim Sullivan, Executive Director, California Public Utilities Commission

Presenters/Panel Members Present

Dr. Daniel Cayan, Former Director, Climate Research Division, Oceanographer and Meteorologist, Scripps Institution of Oceanography, University of California at San Diego

Dr. Craig Zamuda, Senior Policy Advisor, Climate Resilience Partnership, U.S. Department of Energy

Dr. David Groves, Co-Director, RAND Water and Climate Resilience Center

Kathleen Ave, Climate Program Manager, Sacramento Municipal Utility District

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Presenters/Panel Members Present (Cont.)

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Public Present

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Louis Blumberg, Nature Conservancy

Ben Davis

Emily Mazzacurati, Four Twenty-Seven Climate Solutions

Dr. Robert Green, (WebEx)

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P R O C E E D I N G S

JULY 27, 2015 9:39 A.M.

CPUC EXECUTIVE DIRECTOR SULLIVAN: First of all, I'm Timothy Sullivan. I'm the Executive Director of the Public Utilities Commission.

And on behalf of the Commission, I want to welcome you to this workshop today. We are thrilled to host this interagency workshop and we're excited and looking forward to the agenda.

I want to particularly thank the California Energy Commission and the Governor's Office of Planning and Research for coming from Sacramento, down to San Francisco, for this particular session.

I also want to, on behalf of everybody here, I want to thank Commissioner Randolph, who is the driving force behind this workshop and it is she who's brought it all together.

Now, in April, Governor Brown issued an Executive Order that called for major reductions in carbon emissions. In fact, he has ordered us to reduce emissions, carbon emissions by 40 percent below 1990 levels by 2030. And it's the most aggressive goal in North America.

But this Executive Order was also groundbreaking in its call for plans to adapt to climate change.

Because despite everything we're going to do to reduce carbon emissions, climate impacts will still occur.

Today, you will hear from climate experts about the impacts that are affecting us today and those that are anticipated to affect us in the future.

You'll also hear some of the options for adaptation from the experts here in California, and nationally.

We have a great agenda and I think it will be a very informative day.

Now, I was thinking a little bit, before coming here, about, well, what is adaptive change? Well, I think that in most of the literature they think of two types of changes. Technical change, where you change the technology, apply expertise, or create a device, or do something. And that's a technical challenge.

Adaptive challenge is more on that softer side. And if you think about the recycling efforts over the last years, you can see the technical change, which is the new garbage cans that usually are divided, and you put the paper on one side and the plastic on the other. And that's pretty much the technical change. You load them in the cart, you take them away, and each goes on its merry path.

The adaptive challenge, of course, is to get

people to sort their garbage in advance, before putting it out.

Now, a lot of people think of this -- actually, a lot of people don't think of this, but this turns out to be pretty critical.

I'm going to speak a little bit from my own experience. When this first happened in Berkeley, my wife thought that this was a plot against women because, after all, women got stuck with taking care of most of the garbage in the house. And she thought it was just something that was trying to steal time away from her.

Eventually, she got over that. But then, she didn't like the scheme for Berkeley. Berkeley, what we have is we have paper, and then we do recycling, but only if they're stamped with a 1 or a 2 on the bottom. She thought it didn't make sense. She thought a more logical scheme for sorting garbage was dry versus wet.

And so, no matter what happens, our garbage is sorted dry after wet.

On the other hand, this doesn't mean that no adaptive change takes place. Every garbage day, which actually happens to be today, Monday, I take the garbage out to the curb. And I find out that you can fish out all of the cans and bottles, and then just put them and sort them on the curb.

It seemed to be that that adaptive change, in our household, was easier than convincing my wife to sort the garbage according to the Berkeley norms.

The only person in my house who was crazy enough to try and change my wife's idea was actually my daughter, and she's run up into a roadblock.

Now, what I think we'll probably hear today is that adaptive change and adaptation is very fluid. So, I hope you will keep this in mind.

Technical change, although it is a technical challenge, it's often easy. Adaptive change is something that is hard.

Now, I have a few sort of housekeeping messages to say before I turn it over to Commissioner Randolph.

First of all, a safety message. This being California, you never know when the next earthquake will strike. And, actually, within the emergency field, an earthquake is known as a self-notifying event.

So, if we get a self-notifying event, you will see the way to get to a safe place is you go out the doors on either side of the auditorium. And then, we actually have a meeting point, which is actually Jefferson Park, which is on Turk and Gough. And it's a good place to meet in an earthquake because it's open and there won't be things falling on you.

I'm also supposed to make an announcement about ex parte issues. Ex parte is a complex law, which requires the notification and filing of specific information about our proceedings.

So, I'm going to ask everybody to avoid the issues that arise and ask you to not talk about any open proceeding before the Commission.

Also, for those who are -- actually, I guess this is sort of interesting. But today's workshop is being broadcast through the WebEx conferencing system and parties should be aware that you are all being recorded.

We'll post the audio recording on the Commission's website in a couple of days and a written transcript will be available in about a month.

At the end of the day, there will be opportunity for public comments. We're asking parties to limit their comments to three minutes. And if you'd like to make a comment at that time, please fill out a blue card and give it to the Energy Commission's Public Adviser, Alana Mathews, at the back of the room.

Alana, can you raise your hand? Oh, okay, Jovie is -- our person is subbing for her, so that's Jovie, over there in the back.

Okay. And one last thing -- well, that's it for

me. And I want to welcome you all here. And now, I'm turning this over to commissioner Liane Randolph.

CPUC COMMISSIONER RANDOLPH: Thank you, Tim. Our newly-appointed permanent Executive Director, we're very excited.

Thanks to all of you for joining us here today for this important discussion about climate adaptation.

Thanks, in particular, to Kristin Ralff-Douglass and Marzia Zafar for doing a lot of the legwork in putting this together. I really appreciate that.

Our purpose at the workshop is to examine the opportunities for the energy sector to adapt to the climate change that will take place in California and the changes already taking place.

The fact that I'm joined on the dais by colleagues from the CPUC, Energy Commission and the Governor's Office of Planning and Research, is yet another indication that this is a statewide multi-agency and multi-sector effort.

The impetus for this meeting, as Tim said, is the Governor's Executive Order issued in April, in which the Governor called upon each agency to plan for sea level rise and other climate impacts through the coordination of the State Climate Adaptation Strategy.

I was interested in hosting this meeting so that

we could begin to move from the planning stage on climate adaptation to the implementation stage.

The energy sector is taking very aggressive actions to mitigate climate change by reducing our emissions. Utility adaptation measures are also essential. Because even with our mitigation measures, we will still experience the consequences of climate change because of our already accumulated greenhouse gases.

Data shows that climate changes leading to sea level rise, more extreme storms, heat waves, wildfires, changing weather patterns and changing disease patterns.

Though these impacts are certain, we still face uncertainties as to their timing and their magnitude.

These uncertainties lead to our next challenge, determining the cost benefit analysis we should use to determine adequate investment in adaptation and parsing out responsibilities in managing climate change risks between our agencies, regions and communities.

The energy sector is no stranger to assessing risk. In our Resource Adequacy Program we have employed extensive, probabilistic modeling to identify potential outage incidents and ensure adequate procurement for the reliable operation of our grid.

In the area of safety, the Commission's

currently developing risk assessment methodologies to integrate safety into general rate cases.

These methodologies will drive accurate investment in utility programs and infrastructure. We can use these similar skills, that we've developed, to address utility climate change adaptation needs.

I am pleased to see the progress in national and regional approaches to adaptation in the energy sector and methods for developing robust adaptation plans. And I look forward to seeing the continued efforts of the utilities in doing their part to adapt to the impacts of climate change.

Thank you, as I mentioned, to the staff of the CPUC and to the staff of the CEC for putting this workshop together. And thanks so much to Chair Weisenmiller for reaching out and helping us put this all together.

And I will introduce Chair Weisenmiller and he can make a few remarks.

CEC CHAIR WEISENMILLER: Thank you. It's great to be here today and I'd like to thank the CPUC for hosting this event.

I think, when we were in Beijing, the Governor made the point that climate change is one of the things that unites all of us, now, and that it forces all of us

to work together on a global scale to deal with climate change.

And California's had a program for a number of years to deal with climate change. One aspect of that is research and that research has laid a foundation for today's workshop on how our climate is changing, and what that means for us in terms of adaptation.

We also have a very vigorous program on mitigation. And, you know, basically that combination of research, mitigation and adaptation is the way we're going to have to get through this crisis.

Adaptation is the area where, obviously, there's a lot of evolving terminology. All of us struggle with adaptation, resilience, readiness, sustainability. But it's all fundamentally the same thing.

I mean, when we published our third climate assessment, the thing that was pretty clear, as we all know, first that our energy system, the emissions are influencing our climate now. And, at the same time, those climate changes are influencing our energy system.

And that means we really have to rethink. Obviously, a lot of our energy system are very complicated, a long path infrastructure, which is particularly vulnerable.

I mean, obviously, the PUC has the challenge of

not just energy, but telecommunications, water and rail. So, all of that, some of our real fundamental infrastructure that we're making major investments in now, we'll continue to make investments, but we're doing it in what's a changing world.

One of the examples I always use is forest fires. It used to be, in California, that once every ten years we'd have a horrific forest fire. If you were to rank the top 20 forest fires in California history, 13 of them are from the last decade. And, in fact, if anything it's accelerating.

Now, those of us in State service get texts from the Office of Emergency Services on the latest fire. You know, we're now sort of -- I think we're at three in the last few days. So, again, it's something which is not something that climate change -- we're disrupting the climate in the way that it's not something that will affect either just the -- or just our grandchildren, but it's happening now. It's certainly happening in our communities at this very moment.

And, certainly, there's at least a strong scientific debate about whether the drought we're facing is a consequence of our climate disruption or if it's a natural cycle.

But again, we don't have the luxury of not

acting and waiting to find out.

So with that, I'll turn to Ken Alex.

MR. ALEX: Good morning. Thank you for being here. I have to admit that adaptation and resilience has often been the stepchild. I've spent a lot more time thinking and working on greenhouse gas emission issues, and less time thinking about adaptation and resilience. And I think that has to come to an end.

I think, for a long time I thought of it as waving the white flag in some ways. But as was pointed out to me, we can chew gum and walk at the same time. So, we have to pay attention to both and they're inextricably interconnected.

And we're about to embark on some major investments in infrastructure, locally and statewide. Right now, there are two special sessions in the Legislature, one around transportation funding and one around health. Both of those underscore, first of all, the significant needs, as we look into the future in the State of California, in those areas, but also that they are tied, like much of what we're doing in the State, to climate, to climate change and how we respond to those challenges.

So, even as we think about what's next in terms of reducing emissions, of moving away from oil, of

increasing renewables, each aspect of emission reduction also has an aspect of resilience and adaptation, and the massive investment that we're making and the wholesale change that we're making to our energy system.

So, this is an extremely timely effort and workshop by the PUC and the Energy Commission. The Governor's Office of Planning and Research has called out, and the Governor's Executive Order is one of the agencies or one of the entities that is supposed to coordinate response. And during the course of the day, you'll hear about some of those efforts, as well.

But we are absolutely committed to making smart choices and using our limited dollars in an intelligent way, that is about resilience and adaptation.

So, thank you, and I look forward to the proceeding today.

CPUC COMMISSIONER RANDOLPH: And we are joined here, this morning, by CEC Commissioner Karen Douglas and PUC Commissioner Mike Florio.

Commissioner Douglas, did you have anything you wanted to add?

CEC COMMISSIONER DOUGLAS: I just wanted to say, briefly, I appreciate the change to be here. It's nice to be doing this as a joint forum. It's a really important topic.

And as Ken said, you know, it definitely calls for a lot of interagency collaboration, and supported and coordinated by the Governor's Office. So, I'm very happy to be here, thank you.

CPUC COMMISSIONER FLORIO: Welcome everyone, particularly our esteemed guests from the Energy Commission and the Governor's Office.

I guess I mostly want to echo what Ken Alex said, that we spend a lot of our time here, at the PUC, trying to prevent greenhouse gas emissions and climate change. But we do have to also recognize the reality that it's impacting us today.

In some ways, these are the harder things to figure out is where might the threats come from and what do we do about them?

Certainly, some of the states on the East Coast, that were impacted by Super Storm Sandy, have kind of gotten a little bit of a head start on us, through their hard experience. But we know that these threats are just around the corner, if not today.

So, important work, a lot to learn. And I look forward to the presentations. Thank you.

MS. RALFF-DOUGLAS: Good morning. We have a great lineup of speakers this morning. And I am thrilled to introduce Dan Cayan as our first speaker.

He's the Director of the Climate Research Division of the Scripps Institution of Oceanography, and he's also a Researcher with the U.S. Geological Survey.

DR. CAYAN: Thank you, Kristin. I guess that's on. So, truth in advertising. I was the director, I am no longer.

So, as Commissioner Weisenmiller mentioned, California has gone through a set of climate change assessments. Three of them since Governor Schwarzenegger's Executive Order in 2005. And the State is now watching the fourth of those assessments.

I'm going to give you some samples from along that path. Not all of this is entirely currently, but the points I want to make I think are salient, and well-illustrated regardless of the generation of information.

Acknowledgements to my colleagues and to various funding agencies, including those in California, who have made this possible.

So, we're going to take a little fly through on climate change. It's not comprehensive. Time won't allow. But it's targeted towards energy.

Here's a time history, looking retrospectively and prospectively. This is all through the lens of climate models. These days, we actually look at ensembles of climate model simulations, not an

individual model because there is a lot of uncertainty, of various forms.

And what I've shown here in the dark lines are the median values amongst 14 different models. And when we look forward, there's three different scenarios of greenhouse gas emissions and other human behavioral characteristics.

Obviously, the red trace is the higher end greenhouse gas emission, ranging to the brown, sort of a mid-range, rather optimistic. And to the blue, at this point looks extremely optimistic that we would achieve what is called RCP 2.6 -- 2.6 watts per square meter, out of radiation balance by the 2100 mark. The red one is 8.5 watts per square meter.

Currently, we are less than 1 watt per square meter out of radiation balance by various community estimates of what comes in and goes out.

And, of course, the reason that climate change is such a generational problem is these greenhouse gases have long lifetimes. Carbon dioxide, many decades, over a hundred years. And, consequently, the results accumulate.

The other thing about this is, if you notice, these temperature solutions here, they don't really diverge until somewhere near mid-century. And the

reason is that by mid-century the cumulative effects mount to the extent that the different pathways are decisions, Ken's decisions start to matter.

But up until then, we are pretty much indistinguishable, in many ways, in the climate. We are committed to climate change, as Chairman mentioned. And even under the -- at least by the viewpoint of these models, even with the most optimistic solution, we are flirting with the 2 degree Celsius above historical averages, that's the dotted line there on that chart, by the middle part of the century, with each of these scenarios.

So, as Ken mentioned, adaptation cannot play a backseat role. We are confronted, in my opinion, in looking at the evidence.

Another interesting thing about what's coming at us, again from the viewpoint of the climate simulations, is the fact that when you look at the annual cycle of warming it's not a monotone signal. We actually have more warming that will likely occur over land masses in the summertime than we do in the wintertime. And, of course, that involves land surface feedbacks. As we dry out land surfaces, the air near the surface warms even more.

Over the oceans, this is not such an effect and

there's a gradient, of course, along our coast where we're standing, sitting today, to Sacramento. But it looks like we will see, perhaps, a time and a half of the amount of warming in the summer than we may have in winter.

And if we're considering, for example, electrical load from air conditioning, this would seem to be pretty important.

Just as a reminder, I think Craig is going to speak to the electrical system's response to climate change and various measures to adapt.

This is a figure that was put together by authors here in California, including Art Rosenfeld, who most of you know, that illustrates the response of the daily peak load in California. This happens to be for one year, 2004, to statewide maximum temperature population weighted.

And, of course, once we reach mid-70s of Fahrenheit in temperature, then we start to see pretty strong responses. Approximately, a gigawatt of peak load per every degree Fahrenheit of temperature increase.

So, of course, if this translates into the future, and there's a lot of reasons that that becomes complicated. But if it does, a temperature rise of 2

degree Celsius, which is 3.8 Fahrenheit, has several gigawatts of consequence. So, that's certainly a concern.

This is essentially a cartoon of temperature on a summer day, an average summer day in Central California. I'm not trusting the pointer. But we are sitting just off the edge of the southwestern portion of this map right now. And you'll recognize the Sierra Nevadas. That's that blue stripe there. Tioga Pass, most of you know where that is, Owens Valley, and so forth.

The temperature color key is intuitive, so red is hot. You can see Death Valley in this picture. That was today or an average over 1961 through 1990. This is mid-century and that's the end of century, using a -- I would say a respectable, but not presently up-to-date climate model.

But regardless of what model I showed you, you would see something like this as far as the -- essentially the expansion of much warmer temperatures over the California landscape, as we move into the future.

It's not only mean temperatures that will change. It's also extremes in temperature. So, this is a portrait from, in this case, a series of several

climate simulations to show you the amount of scatter. And this is, again, a generation ago. But these are what I labeled as a heat wave in San Diego. In downtown San Diego, we're kind of wimpy, so I labeled a heat wave as 82 degrees Fahrenheit. I know that doesn't make sense to a Sacramento person, but it's all relative.

If I showed you the Sacramento picture, it would be about the same.

In the historical period, under this definition we have about four of those events per year. And each dot is a model. Warm season, between April and October, and I've simply counted the number of events. And there's two different emission scenarios represented here, a higher and a mid-range emission scenario.

And you can see the 20-per-year dotted line there, which starts to be sort of overtaken by about mid-century. And, of course, the higher emission scenario climbs more rapidly and more intensely by the end of the century there.

Heat waves become more frequent, but not only more frequent, but more intense, of course, if we use today's standards. And also, more durable, they last longer.

So, a challenge to not only human systems, but ecosystems, of course, if this plays out.

Another interesting thing is that much as we've seen historically, we know that the amount of warming that we've seen over much of the Northern Hemisphere landscape has been more concentrated in nighttime hours than daytime hours.

And if we look into climate simulations, here we're showing the occurrence of maximum temperatures exceeding the 95th percentile here for the June through August period. This is a slide that my colleague, David Pierce put together very recently. This is down-scaled data, 32 simulations, different global climate models. And, actually, two emission scenarios, 8.5 and 4.5. That's the two different bar and whisker pictures here.

But the take home message is you see a climb in the incidence of the fraction of the 90 days, or so, in June through August, when we find these very warm temperatures.

You can see the swarm of model solutions. That's the gray to yellow background there for the two different scenarios.

But what I would call your attention to, this is the afternoon temperatures and this is the nighttime temperatures. So, what we're seeing is about something like a time and a half more extremes as we move forward in time, in the nighttime, than in the daytime. It

doesn't mean that daytimes are not warming, but it means that the nighttime temperatures during these extreme events are not cooling off as much.

And, of course, I think that, as well, could be a challenge when we look forward.

Another challenge that we have in sort of processing and understanding all of this is that climate models really don't do a great job of lots of different kinds of clouds, including the stratus clouds that affect our coastal area. No stranger at all to San Francisco.

But that's one of the phenomena that really modulates the amount of warming. The easiest way to cool a land surface is to shade it and that's what clouds do.

So, in our collective research activities, this is certainly one of the processes and phenomena that we have to look into more closely as we go forward.

Water and energy, of course, are really tightly tied. And as climate warms in California, we're going to certainly see impacts in our mountain snowpack. We saw that very, very strongly this last year, not only in California, but throughout the west.

And as we go forward, we are looking, optimistically, at probably the loss of about half of

the springtime water content in the California snowpack by the end of the century. So, this is a rather restrained model solution. This is the color scheme is the fraction of snow that remains in early, mid and latter part of the 20th Century, where the blue shading is pretty much 100 percent. The red shading is diving below 30 percent of today's levels. You can see the Sierra Nevada and parts of the Coast Range laid out there.

And you can see the lower parts of our elevational catchments are suffering, first, and strongest. Again, by the end of the century, for this solution, we've lost about half of the California snowpack.

So, we've looked at this, now, with a family of different models, where we've aggregated the entire springtime water content over the California watersheds, collectively. And what you see here is the median being that dark line. Each dot is a model solution. There's 32 different simulations represented here, both higher and mid-range models.

But what I'd like to point out is that we don't actually, in the future, entirely lose a snowy year. It's just that they don't happen that often anymore. And what happens more and more frequently is the fact

that we get extremely depleted snow years, when we have probably both warmer temperatures and, to some extent, deficient precipitation.

We also have, of course, coastal problems. That was alluded to in the introductory remarks. And along our coast sea level rise is -- of course, it's going to be an issue. But it's really going to come to a head when we have big storms and high tides. And oftentimes we see those conditions with other climate situations going on.

Looking into the future, I would say that a mid-range community value for sea level rise along the California coast, over the 21st Century, is about three feet of excess over today's levels. That's the dark trace on this picture.

And the blue sort of histogram-like bars there are the number of extreme high sea level hours. This being a model calculation over San Francisco tide gauge, where in the present day we see such an extreme about one hour out of every year. You can see that in the future, we're really eclipsing that quite markedly by mid-century. And then, by the end of the century, of course, we really have a new game that we're playing. We're seeing exceedances on a very, very frequent basis.

So, much like other extreme phenomena, global

change is really changing, essentially, the mean state. And if models are at all accurate, this is going essentially in one direction, even though there are ups and downs. If you look over the longer period, it's trending up and not returning.

This is what we've seen historically in San Francisco, as far as sea level exceedances. So, we go back here to the World War II period or just after, and looking forward. There were two years that really stand out, those years being very large El Nino conditions of '82-'83 and '97-'98. Many of us were here through those periods and saw some of this.

I think the message here is that sea level coastal problems are not going to occur every year. They're going to occur itinerantly. But as mean sea levels rise, they're going to occur with, again, greater intensity, probably greater frequency, and last longer.

This was a lead in, because I was asked to mention the fact that we have a situation right now in the Pacific Ocean, where the tropics have warmed markedly over this last few months, so there is an El Nino that's in place right now. That's that tongue of warm water along the tropical Pacific, from the South American coast out to the dateline.

And this is a well-studied phenomena. When this

situation occurs in wintertime, at least in some conditions -- it didn't last winter. But in some conditions, it couples with the atmosphere, changes the circulation of the Pacific storm track, shifts that southward. And in some cases, like 1983, like 1998, we get more storminess that penetrates California. Coastal problems, but also big water years.

And, of course, this last four years we've been extremely deprived of precipitation. And one would like to see a game changer coming along, like this.

It probably will not totally circumvent the deficits we've accumulated over four years. But if it does turn out to be a wet year, it will certainly help.

A warning, though, is that when we look at previous El Nino conditions, which are shown here by the red dots, historically this happens to be for the Sacramento drainage, as shown in the inset on that postage stamp little map there, on the bottom right. That what we're showing is the amount of precipitation in each of the October through March, essentially the core winter months that occurred during El Ninos. La Nina is the opposite cool phase of the Pacific Ocean. And neutral phases, that's the middle, green-shaded ones.

What you're struck by is the fact that not all

of the El Ninos are wet. Some of the strongest El Ninos are wet, such as '83 and '98, two dots there at the upper left.

But there's several other cases that give us a little reason for caution in declaring next year to be a wet year. So, just take that as a little bit of cautious optimism as far as this next winter.

So, in summary, we are seeing, no doubt, the early signs of climate change from the atmosphere, itself, to various of our physical systems. The environment that we have grown accustomed to, from historical records, is really not the one that is going to confront us in the decades to come.

So, we have to add to that historical perspective with the evidence, the models and other climate kinds of logic are going to inform us with. There's important phenomena that the models are telling us, such as summers will probably be warming more than winters. There's perhaps more warming at nighttime, than in the daytime. Water and energy systems are linked and there's a whole set of problems and phenomena to contend with there.

Our coastal areas are going to play a role. And in the shorter term, these large El Ninos, when they're tacked onto sea level rise, are probably going to

present us with challenges along the coastline.

Thank you.

(Applause)

CPUC COMMISSIONER RANDOLPH: Do you have any questions?

CEC CHAIR WEISENMILLER: Yeah, I've got a couple. I'll start with a story, where when we lost San Onofre we were looking at the reserve margin we had in San Diego, which under the worst case was going to 13 megawatts.

And at that point the Governor asked me to translate that back to delta in temperature and it was .3 degrees.

So, I guess the story is that as we look at these things we have to think more and more about a lot of our models are sort of average and adverse, either for weather or for hydro. And to the extent both are changing pretty dramatically, it can have really major impacts on our energy system.

We are trying to build into our forecast, now, the changes in temperature that we expect from climate change and so that we have sufficient resources.

But again, I think part of the message is that there are pretty huge changes.

I guess the one thing I wanted to ask you, you

talked about hydro in California and how that's going to be affected. We also relied pretty significantly on hydro from the northwest and also from the Colorado River. So, how does those impacts interact with our hydro changes?

DR. CAYAN: They're very different. The Colorado being the most arid basin in the west. The runoff ratio, the amount of water that gets essentially partitioned into stream flow, into the Colorado system is relatively lean. So, any incremental change increase of evapotranspiration loss to the atmosphere feels large compared to what is devoted to the Colorado flow.

So, warming in the Colorado system will probably result in declines of the Colorado flow in future decades because of the compounding effect. That's simply temperature resulting.

The precipitation solutions that we've seen in the last two generations of climate models are a little different. The third -- the fourth IPCC family of models were a bit drier than the latest, fifth IPCC. So, that's probably some room for optimism.

So, it looks like the southern part of the Colorado Basin may dry a bit over time. The northern part may not dry. If you look at lots of models, the consensus is not real strong there.

In the Pacific Northwest, it does look like the Columbia Basin, which is the seat of where we get a lot of hydro power there, will actually get a little bit wetter. In general, the northern latitudes are becoming wetter as a rule of thumb because the atmosphere is getting moister. So, there's lots of storminess there. And they're likely to actually, I think, become rainier, but not snowier.

So, one of the problems, I think in the Columbia Basin, will be how they deal with more water when they don't actually want runoff, they'd rather have snow storage. So, that's a problem as they go into the future.

But I would say the Colorado is not a -- it's not a good message as far as water supply for California. I don't know if that's -- as far as hydro power, I would think the Northwest is more important. And there, they have a management issue in dealing with a rainier, flashier system than what they have today.

CEC CHAIR WEISENMILLER: It's interesting. From the energy perspective, there's a lot of storage capacity on the Colorado River and very little on the Columbia. So, from a power perspective, those trends are, you know --

DR. CAYAN: Yeah.

CEC CHAIR WEISENMILLER: I had asked you to sort of talk about the El Nino. In part, I know the Marines and Navy were thinking very much about the transmission on their infrastructure from very dry to very wet, and what that could mean for next year.

DR. CAYAN: Well, we hope for very wet, but we're not guaranteed of very wet. So, I would say that this El Nino is certainly looking pretty robust right now. The trajectory over the last few months has been strengthening. The Eastern Tropical Pacific is warmer today, than it was in May. And there's a big reservoir of warmth below the surface in the Pacific Ocean.

So, that bodes well for this situation continuing through the winter period. But we've seen lots of flavors of previous El Ninos. And I would say at this point, this one does not look quite as strong as the two really remarkable events that we saw historically, '82-'83 and '97-'98. So, it bears watching, but I don't know anybody that's really willing to stick their neck way out as far as a wet forecast.

CEC CHAIR WEISENMILLER: No, I think we're stuck hoping for the best, but planning for the worst case.

DR. CAYAN: There you go.

MR. ALEX: Can I ask you, have the models given us any insight into wind? For example, we have a fair

amount of electricity, now, coming from the Tehachapi's. Do we expect over time that that's going to continue, and also in some of the other, windier places in California?

DR. CAYAN: Yeah, that's a great question. Our wind energy is -- I'm probably getting beyond my depth here, but I think we have a pretty strong summer wind regime. And anybody on the docket, or in the audience, can correct me.

I think that's a good thing here because, as I mentioned, we're seeing more warming over the continental land masses than we are over oceans. And that thermal gradient, I think, is going to be -- is going to be reinforced. It's going to be larger in the future, than it is today. And just from sort of seat-of-the-pants logic, that would drive a stronger sea breeze thermal circulation.

The models that we have are very, very granular. They're computed at spatial grids of 200 kilometers, or something like that. So, they don't handle this kind of Meso-scale circulation very well.

So, I think one of the messages here is the importance of the regional modeling with dynamical models that have, you know, solve the equations of motion and so forth, in order to verify those empirical

results.

We've looked at large scale features from some of the models and done a statistical gambit to try to get out this, and they look promising as far as the circulation. But I don't think we can be entirely confident without going through the next step of the dynamical solutions.

So, you know, I hate to be a researcher, calling for more research, but that's what I just did.

CPUC COMMISSIONER RANDOLPH: Okay, thank you. Were there any other questions? Okay.

I especially want to thank Dr. Cayan for coming in on such short notice, we really appreciate it.

And thank you to Guido Franco, who helped secure the speakers. He's my partner in crime on this event.

Our next speaker also dropped a lot of things to come and talk with us today. Dr. Craig Zamuda, from the DOE Resilience Partnership. And so, I'd like to invite him to come speak to you next.

DR. ZAMUDA: Good morning. Let me thank you for this opportunity to join with you, both the Public Utilities Commission, the Energy Commission and the Governor's Office. I appreciate the opportunity.

Very timely, a conversation to be having, and always a challenge to follow the inspirational notes.

Dan, thanks for that uplifting morning conversation in terms of the challenges that we have out there.

Hopefully, I can provide a transition from the good, the bad, the ugly to there's hope and optimism for the future. Because the good news is, there is.

So, I'm going to spend a few minutes talking about some of the work that we're doing at the Department of Energy, both to help characterize what are the vulnerabilities that lay in front of us with regards to the energy sector, what are some of the resilient solutions that are out there, that we can employ today and, hopefully, innovate technologies that are coming tomorrow to lower the cost of innovation and resilience.

And third, I guess is to talk about the partnership. We recognize that the majority of energy infrastructure in this country is owned and operated by the private sector. So, we recognize that to be successful in terms of resilience we're going to have to partner with the private sector, and state and local governments, because all of these decisions will ultimately be local decisions in terms of improving resilience.

So, let me start with some of the drivers we have at the Department, including the President's Climate Action Plan that we're celebrating the second

anniversary of that plan.

That plan really provided a framework for how we're going to, at the federal level, look at mitigation and adaptation. And it, in essence, requires all federal agencies to develop adaptation plans and implement those plans.

So, going back to Commissioner Randolph's comments, we need to move just beyond the planning phase and getting the implementation. So, that's a requirement for all agencies to do that, to look at their mission, look at the impact of climate change, assess their vulnerabilities and put in place effective resilient strategies. Whether the part of the mission they're looking at is domestic or international.

Also, there are a couple of reports that have come out. One that California helped develop in the State, Local and Tribal Leaders Task Force that reports to the President, reported to the Council on Climate Preparedness Resilience.

Included membership from California, it included the Governor from California, and several mayors from California, as well as representatives from throughout the country.

This is a report that really laid out recommendations in terms of what the federal government

ought to be doing with regards to climate adaptation. Not just in the energy sector, but across all sectors. So, that has helped drive the work that I'm going to be talking about here, today.

And most recently, back in April, the Administration issued a report, the Quadrennial Energy Review, which took a broad look, and looked to the future in terms of what are the implications with regards to our current energy system, with regards to energy security, energy reliability, energy resilience. Where are those actions that we need to be pursuing as we move forward. So, all of these instruments have helped frame the work that we're doing at DOE.

I guess most practically speaking is work that we've done in terms of analytical assessment of climate trends in the U.S. and those impacts. So, we issued a report, that you see the image of here, back in 2013, that looked across the U.S. It looked at climate change, really, from three basic drivers. And that is decreasing water availability, increasing temperatures, and increasing sea level rise, intensity, storm surge, et cetera, and more intense hurricanes, and how do those three major climate-related risks impact the energy sector?

And I won't walk through each of these

particular impacts. But you can see, with regards to decreasing water availability, it's pretty straight forward. Thermoelectric power plants require water. Less water, less ability to generate electricity. Ditto for hydro power. You all recognize that here, in the great State of California, in terms of available water for hydro power and how that capacity has been diminished, particularly in the last year or more.

Also, with regards to increasing temperatures, we see how energy demand will go up, increased need for cooling, increase penetration of air conditioners, et cetera. At the same time that demand is going up, we see the impact of higher temperatures on energy supply.

So, for thermoelectric power generation, the efficiency of generation decreases at warmer temperatures. For transmission and distribution of that electricity, it also decreases with warmer temperatures.

So, we see this imbalance between the effects of climate change in terms of decreasing supply, at the same time -- sorry, in terms of increasing demand, at the same time of decreasing supply.

Similarly, for increasing sea level rise and storm surge, particularly on the East Coast and Gulf Coast we've seen the impacts. We have both subsidence going on, as well as higher sea level, which is having a

significant impact expressed, as was referred to here, with Super Storm Sandy. A classic example where not even a fairly intense hurricane, but the perfect storm in the sense of you had high tides, you had the increased force of winds and sea level rise all combined to have an impact.

Not just on the electricity assets, but these interdependencies of electricity on other sectors. Both the energy sector, where gasoline stations couldn't supply gas because they couldn't drive their pumps, and also on communication, transportation, water treatment. We have billions of gallons of raw sewage basically being dumped in the nation's waterways because the wastewater treatment plants didn't have electricity to be able to safely operate.

So, we see these implications. I think the key takeaway here, with regards to that report, was climate change and its impact on the energy sector isn't something we need to look to in terms of the future. It's here and now. It's having a significant impact in terms of cost and damages today.

The little cartoon on the bottom right, as we try to give actual examples over the last few years, where climate trends have actually expressed themselves and having impact on the energy sector.

The other thing is that there are actions underway. I think this afternoon you're going to hear from a number of utilities, work that's going on.

Our assessment in 2013, when we did this report, was, indeed, there was work going on to enhance resilience. But the pace, scale and scope of those activities were not in keeping with the nature of the challenge.

I just want to talk briefly about the work that the Department of Energy is doing, really in four major pillars. I'm going to come back and spend the rest of my conversation on the last two.

But I did want to highlight the fact that there are significant assets out there, in terms of our national laboratories. You have two here, in California, Lawrence Berkeley National Laboratory and Lawrence Livermore National Laboratory.

We have other laboratories across the nation who are kind of our research jewels for the country, working in collaboration with the universities and the private sector, or developing innovative technologies.

These technologies can be looking at energy efficiency, both building efficiency, appliance efficiency, and can be looking at smart grid and distributed generation that are part of the portfolio of

options in front of us, in terms of enhancing resilience.

They can be looking at more water and energy-efficient energy technologies. Now, we have this nexus between energy and water. For water you need energy, for energy you need water. For both situations we need to be more efficient, both with regards to energy and water.

So, there's a lot of work that can be done. But I think one thing we need to recognize, most of the energy infrastructure we're looking at, out there today, is as old as some of the people speaking to you today, all right. So, it was designed and built for the 20th Century.

And so, with regards to the need for innovation, there's a lot of technologies that are on the shelf today.

And what we need to do is really look at the second point, looking at the barriers. What's preventing us from investing in the technologies that we have today that can result in a more resilient energy sector? At the same time, where are the gaps where we need to be investing into the future?

The last two areas, in terms of the portfolio of work that we're doing at the Department is really to

look at providing better technical information, assistance, and decision support tools.

The previous speaker talked about climate resilience and global change models, and the need for greater granularity. Where it may be interesting to know what's going on, on a global basis, but you're making investments at the local level. We need that greater granularity in terms of what the trends are at that local level.

And we're trying to develop better models, better information to be able to provide that kind of information that will be useful for decision makers.

And, finally, we're all in this together. So, no matter where you look across the country, climate will have an impact. It affects all regions, it affects all elements of the energy sector. And so, working in a more collaborative fashion, and I'll talk about some of the examples that we're pursuing in the Department with some of the folks that are represented here, today.

I mentioned the report we put out in 2013. We're about to release a companion piece to that document. Hopefully, that will go out this month, although the days are growing short for this month. But I'd say within the next few days.

This report is A Climate Change in the U.S.

Energy Sector, Regional Vulnerabilities and Resilient Solutions. So, I'll talk a little bit more about that in a moment.

But the key thing between that first report and this report, we're diving down with greater detail, greater granularity in terms of regional implications.

Also, in terms of information and tools, so there's a lot of information out there, a lot of tools, models, et cetera that the Department has developed, that the federal government has developed. The key is to make those available to potential users, the stakeholders, the folks here in the room.

And there's one of these initiatives that were part of the President's Climate Action Plan. It's the Climate Resilience Tool Kit. I don't know if you're familiar with that. I've provided the link up here and I assume that these presentations will be made available as a follow up.

The Climate Resilience Tool Kit was really the government's attempt to put the information that it has into the hands of stakeholders.

And the energy theme, the Climate Resilience Tool Kit cuts across all sectors, transportation, communication, health, et cetera. The energy theme of that went live back in June.

So, if you haven't availed yourself of that resource, I'd suggest you do that.

And, finally, with regards to work that we're doing with regards to this particular pillar of the Department's portfolio, is really developing methodologies to better characterize what the cost and benefits are of investing in resilience.

It's pretty straight forward to talk about the costs of the investments. You just call an engineer in and they can kind of characterize what it's going to cost to employ some of these technologies.

The benefits is a little bit more elusive in terms of how do you characterize the benefits of some of these against some of these risks, that are kind of long-term risks, that are growing over time. There's some degree of uncertainty associated with them.

And, most importantly, a lot of the risks that you need to be addressing isn't just changes in mean, or annual temperatures, or rainfall, it's the extreme events. Okay, that's what you really have to be prepared for.

And the probability of those extreme events, looking at the benefits when you look across this probability, et cetera, is a little challenging and needs additional work. And we're hoping to make

advances in that regard.

With regards to the report, itself, this is a report that we really look at as diving deeper, in terms of looking at climate trends at the regional level, looking at vulnerabilities at the regional level, looking at potential resilient solutions. And so, the report actually provides specific examples of things that are going on across the nation, for each one of the regions, to build greater resilience.

We look at the audience as being folks represented here, state and local decision makers.

And the value we envision for this is providing an objective analysis that can help in terms of screening vulnerabilities, and in terms of developing that first cut of what resilience strategies could look like.

We basically have adopted the National Climate Assessment's framework for looking at the different regions. There's nine chapters outlined in the cartoon here, on the lest.

We look across all the energy sectors. I'm sorry, you can't make out those subsectors very well, I guess. But we're going from energy supply to energy demand, and all the subsectors associated with that, be it thermoelectric, be it hydropower, be it fuels.

And for each chapter, we'll go through and address both what are the energy assets in that area, what are the vulnerabilities, what are examples of resilient strategies, and what are some of the options that may not have been exercised, yet, but can help contribute to greater resilience.

I pulled out some of the information from our Southwest Chapter, which includes California. And you can see these are examples of types of information we'll highlight. So, we'll talk about the higher temperatures, increasing air conditioning penetration, increasing energy demand, particularly during those summer peak demand periods.

At the same time, we'll talk about the effects of higher temperatures on the efficiency of generation, the capacity to provide the electricity, and how that will be impacted by climate change.

And we'll talk about things that the prior speaker talked to, about the effects of climate change on the precipitation patterns, both in terms of the amount of precipitation. I think he was contrasting the southwest, on average, is expected to have less precipitation in the future than the northern parts of the country.

But also, in terms of not just the amount of

precipitation, but the form of that precipitation. So, increasingly, in the form of rain versus snow. So, that storage mechanism you have for that winter snowfall, that you could be relying on for summer hydropower, when that falls as rain versus snow, you've lost that storage capacity. So, increasingly, we're going to have less water available for hydropower production, perhaps during that peak demand period during the summer.

With regards to resilient strategies, we go down a list of various actions that can be taken, from new capacity additions, hopefully, with climate-resilient technologies.

So, moving away from water-intensive, thermoelectric generation to, perhaps, application of dry cooling technologies, or wet-dry hybrid cooling technologies, which has a significant smaller water footprint.

Or moving towards renewables, such as wind, PV solar, with literally minimal water footprint.

So, these are all technologies that are out today. The progress is being made to deploy these types of technologies, but having a more concerted effort is probably more responsible as we move forward.

Other things, besides just those types of technologies. Smart grid, the ability to have better

control over the flow of electricity, to be able to isolate disturbances and outages and more quickly recover from those. And in terms of demand side management, where during that peak demand the utility may have the opportunity to go in and kind of control the amount of energy that's being used by consumers, and work out cooperative working relationships with consumers so that's an acceptable way to manage the problem.

Turbine upgrades. You may be familiar with Lake Mead. You've seen the kind of the water bath ring around the column there. And, you know, over the years those turbines, because there's less head to generate power, that decreases the efficiency of those turbines. So, there's increasingly efforts to replace the older turbines with more efficient turbines that can operate with lower head to generate the turbines.

And in terms of vegetation management, with regards to wildfires, vegetation management changing, hardening the infrastructure. Moving from wooden poles that would be susceptible to fires, to concrete/steel poles. There's a number of things that can be done. And the report tries to go through each region and kind of outline some of the work that's actually going on today.

We also tried to pull together an inventory of what are the things out there and have that included in the report. I'm not going to talk to this slide, other than to say if you get the report, you can see how the various resilience options associated both with physical hardening of energy infrastructure, as well as with regards to planning and operation of that infrastructure and actions that can be taken.

So, this is our first shot to really pull together an inventory of those options available. We'll follow this up with more detailed information, including information related to the cost and benefits of these types of options available. So, that should help in the decision making framework.

In terms of specific examples, I alluded to the fact that it's not just a conceptual description of what we could be done, we provide multiple examples of things that are going on.

Here's an example in terms of what are we doing with regards to heat waves, and higher temperatures. And the example is like Florida Power & Light, who are instituting efforts to control peak demand with their customers, and they're providing certain rewards and incentives to allow that to happen. Rebates for enhancement in the appliances, like air conditioners, to

have more efficient air conditioners out there. All with the effort of reducing that demand during that peak time period.

Entergy, another example, working in terms of weatherization and energy efficiency initiatives to lower their demand. I would say, I've listed Entergy here, but I would be remiss if I didn't note the great work that Entergy has done in terms of looking at sea level rise and storm surge in their Gulf Coast Study.

So, a classic study of looking at not only what the threats may be, as you look out over the decades, but also doing kind of a cost benefit analysis in terms of showing what are the different options that you can implement. So, credits to them for that.

With regards to water availability, we mentioned the northwest in terms of hydro power and the impact of greater amounts of precipitation falling as rain, rather than snow. And so, utilities like Seattle City Light, in this region that relies heavily on hydropower, are getting a better handle in terms of what do stream flow projections look like. How do they better manage the hydrology to ensure that they can maximize generation from hydropower.

An example here for Arizona Public Service. That, rather than using traditional fresh water has

shifted to using municipal wastewater for providing the cooling water for a nuclear power plant, one of the largest nuclear power plants in the world.

And energy in their work, in terms of concentrated solar power and using dry cooling technology to really reduce that water footprint.

A few more examples, in terms of frequency of wildfires. I think California sets the pace in terms of dealing with the wildfire issues, both in terms of the requirements set out by the Commission, as well as that being implemented and adopted by the utilities.

Some examples here of just the hardening of the infrastructure, better planning in terms of fire maps, et cetera, in terms of looking at that threat. So, a lot of work going on there that should be adopted elsewhere, as well.

And the rising sea level rise. Once again, with Super Storm Sandy, we have ConEd, Consolidated Edison. In that region, you know, 8 million folks without power for some period of time, cascading impacts across a number of sectors. ConEd is coming back with a multi-year, billion dollar strategy to harden the infrastructure.

Right now, they're in the process of addressing 23 substations that were flooded in lower Manhattan,

raising those substations, making them basically flood proof, if you will. A lot of work going on with regards to that.

There's another example in New Jersey. The City of Hoboken is working with the Department of Energy, Sandia National Lab, and Public Service Electric & Gas to have one of the nation's first micro grid systems for a transportation system. So, you have hundreds of thousands of folks that are using this transportation system in New York, New Jersey. When the power goes out, the system crashes. And so, there's effort underway to create a micro grid, so that even if the power in the general region goes out, there would still be power to drive the mass transit system.

So, let me skip ahead here and talk about the final aspect of this, which is partnership. So, as I say, we're all in this together. There's a number of things the Department is doing. I'm going to talk more about this recent partnership that we established, but we have actions going on in terms of the Climate Action Champions.

San Francisco is one of those champions. There are other entities here, in California. But the Climate Action Champions really is an award program to those communities that are significantly invested in both

mitigation and adaptation, and to provide those communities with some additional assistance to help them serve as the nation's champions in that regard.

We're also doing work in terms of energy assurance planning with states, to help them improve the work that they're doing.

With regards to the partnership, we really wanted to move away from kind of the one-off workshops that are kind of done on a periodic basis across the country, and really have a sustained engagement, where we could work with a collective set of utilities. At least, initially, the utilities. We look to expand this to move into the oil and gas arena at some point. But right now, we're starting with the electric utilities.

And have a sustained conversation with them, with regards to a number of factors, including kind of sharing lessons learned. What are we doing and how are we doing that? How can we do it better?

Sharing information, I mentioned the Climate Resilience Tool Kit, making sure utilities are aware of the information that's out there that can be used, as well as they're aware of the information that they can share amongst themselves.

Looking at incentives and the barriers, and making sure that we can remove barriers that are out

there. But, equally important, provide incentives to making these investments in climate resilience. So, we want to examine that.

On the cost benefit side, clearly, you all have experienced the case where utilities are wanting to make these investments and the decision to pass these costs on to the ratepayers isn't always a hundred percent successful.

We want to better position everyone to have a more standardized methodology in terms of how we're doing this, so we can accelerate investments as we move forward.

Metrics, there really aren't any clear metrics. We'll talk about, all day, about having a more resilient energy system, but what do we mean by that? And what are the clear metrics that we can use?

We have metrics out there that are commonly adopted for reliability. On the resilient side, not so much. So, we need to do a much better job of defining what we mean by resilience? How are we going to measure progress as we move forward.

And I think, lastly on this slide, we also want to recognize, we want to use this partnership to recognize the leaders in the country, who recognize that climate change is a risk to the energy assets and are

taking actions to improve resilience.

Where are we now? The Vice President and Secretary Moniz announced this partnership back in April, as part of the Quadrennial Energy Review. The Secretary of Energy then had a meeting with the CEOs and senior management from all the partners. We're up to 17 companies as founding members.

And is Southern California Edison here, in the audience? Great, we welcome our 18th member that has joined us this month. So, we are growing. And our goal is to continue that growth.

Even at 18, we represent, we have a pretty big footprint. So, 20 to 25 percent of the generation capacity in the country and in terms of the customers served in this country.

We have a broad array of the types of utilities that are represented here. And you can find your favorite utility up on the list. As a helpful hint, the ones in yellow are the ones that are from California. But we have them ranging from investor-owned, to federal, state and cooperatives out there. And, geographically, we cover quite a span of the U.S., but our goal is to grow that as we go.

Actions underway, we're continuing to conduct outreach. We're conducting a series of webinars,

workshops, conversations to maintain the sustained engagement.

There are two principal areas that I'll end on. Each partner, in joining the partnership, agrees to conduct a vulnerability assessment of their assets and develop a resilient strategy. Nine months for that goal line.

So, we're working with all these utilities to make sure they've got the tools they need, the guidance they need. And we'll come back at the end of that nine months to compare what we have, to look at those vulnerability assessments, identify opportunities for improvement.

The next phase of that, really, beyond the continuous improvement of doing vulnerability assessments, gets on to resilience strategies. Within 18 months of joining the partnership, they need to put together a resilient strategy.

So, we are moving forward to look both at the implementation, as well as the planning aspect of this.

And I'll end on the cost benefit piece of this. As I mentioned earlier, it's important to get that right. We're in the business, right now, of trying to develop a general methodology that could be applied to look at coastal energy infrastructure, to be able to

accurately characterize potential damages and cost of climate change. As well as to look at the cost and benefits of resilience investments.

Our goal would be then to apply that methodology in a particular geographic region, and then disseminate that more broadly, as well as expand that to move beyond just threats, such as sea level rise, storm surge, and to look at other threats such as heat waves, and other climate-related risks that we have.

So, our goal is to try to come up with a more standardized, uniform methodology that could be adopted. Not as a requirement, as much as for helpful guidance to help bring some consistency in terms of the way we're doing business.

So, I'll end there. I might have gone significantly overtime. I apologize, if I did. But if there's any questions, be willing to take those.

CPUC COMMISSIONER RANDOLPH: Thank you very much. That was very interesting.

(Applause)

CPUC COMMISSIONER RANDOLPH: Ken, you had a question.

MR. ALEX: I have a quick question, which is does DOE consider generation and storage a resilience strategy? And, do you have any goals for increasing

those percentages?

DR. ZAMUDA: Yeah, so I'm trying to pull up a slide real quick. Traditionally, in the past, I think the majority of the work the Department of Energy's been doing, as others have been doing, has been focused on the mitigation side, the greenhouse gas emission reduction side.

The good news, and as you noted earlier in your comments, that there are co-benefits between the mitigation work and adaptation work.

And so, I've tried to put a slide up here that frames the world of mitigation and resilience, and shows that nexus between the two.

And so, things like enhanced energy efficiency, renewables, I'd say demand management, a lot of that work not only has benefits in terms of reducing greenhouse emissions, it has benefits with regards to building a more resilient energy system.

So the good news is we've been doing some of this work, already, as a nation. We haven't necessarily branded it as adaptation work. But we're moving forward to build upon that work that has been done.

So, there's certainly a role for demand management. Certainly a role for smart grid, automated switches to more readily identify where the outages

occur so they can be responded to and get those back online.

So, there's a lot of work, I think both in the energy efficiency side and the demand management side. And you see some examples that I alluded to, that we capture in the report. But those are certainly options. Not simple to deploy, it takes a cooperative working relationship between the supplier and the user. But there's certainly areas that we've seen success across the country and we want to build upon that.

I don't necessarily think we have any specific, defined goals, you know, quantitative goals out there today. But we should certainly be looking at how do we incentivize and accelerate the work that's going on.

CEC CHAIR WEISENMILLER: Yeah, a couple questions. One of them is, given the importance of hydro in the context of BPA, WAPA and the Bureau, is there any special focus on what climate change means for re-engineering our hydro systems?

DR. ZAMUDA: Yeah. So, Congress has asked for reports in terms of looking at hydropower, federal hydropower generation in this country. And the first report, which did not really look at climate projects, the first came out a year or so ago.

There is another report that should be issued

shortly, in the months ahead, that will factor in climate projections and what the implications are across the country for federal hydropower production, which is a pretty significant component of our hydropower production.

And in looking at that report, it will then also be looking at what are the options. I think, it wouldn't be a surprise to think that there are regions where, with climate projection, hydropower generation capacity is going to decrease. If not decrease on an annual basis, at least on a seasonal basis.

And so, the report will look at what some of those resilience options can be.

And if I could, just one moment on annual versus seasonal. I think it's important for us all to keep in mind that with regard to water, it's one of those things that you need 24/7, okay. And there are projections out there, I think previous speakers spoke to that in terms of annual precipitation for the country.

And for the northern regions, we're expecting that there will be an increase in average annual precipitation. In the southern regions, not so much.

But even in those northern regions, and recognizing the interconnectedness between California, and Washington, and Oregon with regards to hydropower,

it's important to keep in mind that even though the average annual precipitation may actually increase north of here, that all projections are basically suggesting that seasonally, summer precipitation will decrease.

So, you have this combined issue of less precipitation in summer. Significant amounts of that previously available snowpack now falling as rain, and not being available in summer. And you can start seeing what the implications are. Not throughout the year. Potentially, hydropower production in the winter may increase. But it's in summer where it looks that the peak demand is going to be and where the problem is really going to be an issue of supply and demand.

CEC CHAIR WEISENMILLER: Okay.

CPUC COMMISSIONER RANDOLPH: Oh, did you have another question?

CEC CHAIR WEISENMILLER: Just one last question from me, if you don't mind.

One of them is just in terms of we, the Energy Commission, has been very focused on climate change and the energy system, as have you. Is there anyone in the federal government that's looking more at the implications of climate change on like the telecommunications system, or the rail system, or water systems?

DR. ZAMUDA: Yeah. So, as I alluded to at the very beginning, that all the federal agencies are needing to look at their mission and look at the impacts of climate change, and assess those vulnerabilities and put in place resilient strategies.

So on transportation, we have the Department of Transportation who has that as an area of responsibility. They have done a number of reports, looking at different sections of the country, looking at the vulnerabilities of climate change to those sections and identifying kind of resilient strategies.

So, there's work going on throughout the federal government, sector by sector.

I think, perhaps, an area that is less emphasized today, and we're moving in that direction, is the holistic view of the world, right, and these interdependencies that exist across all of these sectors, and making sure that we haven't developed these resilient strategies kind of in isolated stovepipes, but have kind of looked at them from a holistic, community perspective.

I mean, that's what you're having to do at the state level, the local level. At the federal government level, quite often we get in these little stovepipes and do the responsible thing, but it's not from a holistic

perspective and we need to do more of that.

CPUC COMMISSIONER RANDOLPH: I found the discussion of the partnership for energy sector, climate resilience, particularly interesting. Do you currently have or do you anticipate a role for regulators around the nation to participate in those kinds of conversations?

DR. ZAMUDA: Thank you. So, as we've stood this up, our focus was, in terms of actual members, to be private sector companies. But we recognize that we need to broaden that conversation in some capacity to include regulators, for example. To include the Utility Commission, for example, and others.

So, we're trying to figure out what's the right roles and responsibilities. But let make the offer, as I'm wrapping up here, that we would encourage engagement with utility commissions, with the regulators. We need to have that conversation.

Even in the work that I referred to, in terms of developing methodologies to look at cost benefits, that shouldn't be done in isolation.

You all are in the position of making these decisions of whether these investments are going to move forward or not. You should be part of that conversation and we'd welcome the opportunity to engage with you.

CPUC COMMISSIONER RANDOLPH: Thank you. Any other questions?

Okay. Thank you very much.

DR. ZAMUDA: Okay, thank you.

MS. RALFF-DOUGLAS: Again, thanks very much for making your way out from D.C. for this.

(Applause)

MS. RALFF-DOUGLAS: Our next speaker is Dr. David Groves. He is the Co-Director of the RAND Water and Climate Resilience Center.

I just want to make a quick announcement that there are copies of the presentations on the back table, and they're also available on the web, so you'll be able to refer to those in the future.

DR. GROVES: All right, good morning. Thank you very much to the Commissioners and Kristin for inviting me here today. I'm really pleased to be here, to talk to you all. And I just realized I don't have my clicker. Does this go full screen or are we -- okay, I guess we're good.

So, let me just say a few remarks. So, to begin with, my role today is not really to tell you about why we must adapt to climate change. You know, Dan Cayan produced or provided plenty of evidence on that front.

And also, I'm not really here to talk about

adaptation strategies in the energy sector. You know, Craig motivated that well and, actually, a lot of the speakers that are following me will hit those in real detail.

But instead, what I'm here to talk about is methods for planning under climate change, you know, which we've developed over the years and we see increasingly being incorporated into plans. And I want to talk to you about these methods and how we've applied these in the water sector so it can provide a nice framework, I think, for some of the other talks that will be following.

And in particular, we're really talking about how to move from vulnerability assessments to adaptation planning and decision making. So, making specific decisions on specific investments, recognizing that these are costly and there are tradeoffs involved.

As I mentioned, my colleagues at RAND, and other research organizations across the globe, have been thinking about methods for planning under uncertainty for the last decade.

But, you know, research and practice really should go hand in hand. So I'm please to, you know, having skimmed some of the presentations that are following that, really, you know, we're seeing new

methods on how to plan for uncertainty really being incorporated into the art of practice for planning for climate adaptation.

So with that, let me dive into my presentation. I'm going to just try to highlight some key principles about how to plan under uncertainty, and then illustrate how we've applied this in the water planning sector, specifically with the Colorado River.

So just to provide motivation, which you all are very comfortable with, I'm sure -- or not uncomfortable with, but are aware of.

The uncertainty underlies all aspects of climate adaptation planning. And some of the big uncertainties are, well, how might the climate change? Is it going to get wetter? Is it going to get drier? How much hotter? How are extreme events going to be impacted? And we've got a lot of scientific information that provides indications of how these changes might occur, but there's still inherent uncertainties about it.

And how those uncertainties play out really could have a big impact on which types of adaptations make the most sense, are most cost effective, balance objectives most appropriately.

Climate change is also not operating and happening in a vacuum. We have climate changes

occurring on top of, of course, natural variability, as Dan Cayan mentioned in his talk, but also across all sorts of societal changes, demographic growth, technological innovations. And how all of these things come together is, in many cases, just as important as the climate change driver, itself.

So, I'm just saying how these things all interact together can be highly uncertain and very, very relevant to your decision at hand.

How do we -- you know, if we recognize that there's lots of ways the future can unfold over the coming years, how do we plan when we have this multitude of potential futures? We don't really know how likely any one future is.

And then, we also don't have a single goal in mind. You know, with energy planning we're certainly interested in keeping costs low, keeping reliability high, but we have all sorts of other considerations that are very important. And there's no one, single objective function out there that we can just put all our energy to and try to identify how do we best maximize that.

And then lastly, you know, it's cut off the screen here, but how do we support public dialogue over our different choices? You know, adaptation doesn't

happen in a vacuum. It's a public process. It requires the participation of many organizations, many people. Actually, everybody in fact. And so, you know, it's not going to be something that's going to come out of a study and a report that's going to sit there, and people are going to reference the report and say, oh, this is what I'm supposed to do.

It's going to come through dialogue, meetings like this, workshops like these in which the organizations and people understand what's at stake, understand their choices and then, you know, policymakers and regulators properly incentivize the right kinds of adaptations.

Okay. So, traditional decision methods are fine if we don't face much certainty. And, you know, this is just a -- it's a little hard to see, but basically what I'm just describing here is sort of a traditional way of thinking about making a decision.

You might think about what are the future conditions and then what's the best choice today, given some understanding of what we're going to face in the future. And then, there might be some sensitivity analysis.

I think most people in this room recognize that this is a good approach, really good for building

airplanes and things, where we have really good engineering data. And, you know, it's good when things are changing too fast, when we can predict what's going to happen, when there's not a lot of disagreement on outcomes.

But these kinds of approaches can really backfire when we have the potential to underestimate our uncertainties or we have differing groups of people that have different ideas on what's going to happen, or what could happen. And competing analyses could lead to gridlock.

And it's also problematic when we think we know what's going to happen, and we plan for it, and that may not be a very good strategy or solution for what eventually does come to happen.

Some of our recent climate-related disasters come to mind, you know, Katrina, Sandy, things like that.

So, as an alternative, which -- so an approach that I think is a bit more appropriate is we need to combine new methods, and then we also need to do that and bring that within a data-driven, participatory planning framework. So, I'll talk a little bit about each of these.

In terms of new methods, what we want to do is,

rather than predicting what's going to happen and coming up with a strategy, instead we want to understand what the vulnerabilities are to our leading strategies. And then look at ways to reduce those vulnerabilities, either through hedging action, so things that can -- I think things that can lead to better performance if bad outcomes occur, or shaping actions where we actually try to make sure that we end up with a future that's going to be favorable for, in this case, our energy system.

And so, this framing turns things around a little bit. It decreases the emphasis on predicting what's going to happen, characterizing the uncertainty precisely or statistically and, instead, into understanding what's vulnerable and what are the tradeoffs among different solutions.

And as I said before, you know, we see a lot of the talks and a lot of the conversation really shifting to this kind of thinking, so that's a really good thing.

This kind of analytical process needs to be supported by stakeholders and the participation of the decision makers that are to be benefitted by it. And, you know, increasingly, practitioners and researchers are turning to new analytical tools. It's much easier to make interactive visualizations that can help people engage with the research.

And we've found, and I'm certain many in this room have found, that that can be a really compelling way to bring people around and understand what the key tradeoffs are, and help forge a decision.

So this approach, by our group, has been applied across the globe and many other groups, probably all the other blank spaces. But I want to just highlight that, you know, I'm drawing from work that we've done across the U.S., and Northern and Southern California, on the East Coast, as well as some international work, supported by either the international government or the World Bank, all looking at sort of climate adaptation. You know, what are the climate vulnerabilities and what are different adaptation strategies that can reduce that vulnerability.

And we have more information about this work on our Center website.

So, yeah, we've implemented this and worked in many different settings. What I want to talk today about is a setting in the water sector. But, of course, the water and energy are linked. And part of this study looked at the energy implications of climate impacts on the Colorado River. And I won't talk about that specifically, in detail. But, obviously, I will put that that's study's out there and many of you are

probably very familiar with it.

So, what I want to talk about is the Colorado River Basin Study, which was released in 2012. And it used, you know, these approaches that I'm talking about to look at climate vulnerability and evaluate different adaptation options and strategies.

And just -- I'm sorry, my fonts are all overlapping here. Just a bit of review, provides water for 40 million people, seven states, billions of dollars of economic activity.

We have, you know, the Upper Basin, we have the Lower Basin and there's a complex set of rules that govern how water is managed across those two basins. There's lots of -- you know, we've got hydropower, a tremendous amount of hydropower on the system. It also supports, obviously, tremendous natural resources. I think here I'm citing 24 national parks, wildlife refuges and recreational areas.

Some key facilities on the Basin, which are very good indicators for the condition of the Basin and can be used as ways to monitor the health of the Basin, are Lake Powell and Lee Ferry. So, Lee Ferry is an area where you can measure the flow from the Upper Basin to the Lower Basin. And Lake Powell is the large, upper reservoir. And then, Lake Mead and Hoover Dam, outside

of Las Vegas, is a good indicator -- the elevation of that is a good indicator for the health of the system in terms of supplies available to the Lower Basin states.

And, you know, as many of you probably know, right now Lake Mead is very, very near its historical low point, and which is dangerously close to a level that would trigger shortages to some of the states, some of the seven states.

So, we have challenges right now. But we also, when you start looking out in the future we have growing challenges. And this is a graphic that we used, you know the study produced, to help contextualize the challenge.

So, this is a time series of water use in red, and supply in blue. And you see, over time, the gap between the available supply and the demand is diminishing. And then, as you go out into the future, the projected water demand exceeds the range of projected water supply. And this is a fundamental challenge and suggests that something needs to be done to address this.

And this is driven both by climate change, which I'll talk about in a second, and also changes on in terms of the water needs by the Basin users.

So, we turned to -- yeah, so we turned to an

approach that we call robust decision making to help sort through what could happen on the Colorado River, and sort through all of the different types of options, and come up with a robust strategy to move forward.

This is sort of one way that we like to talk about this. This is not going to seem completely foreign to many of you, and certainly planners in the room. We start with a decision structuring step. I'll talk a little bit about that.

But based on that decision structuring, we develop hypotheses for what the future could look like. We develop large numbers of futures, and what you might think of as scenarios, under the case generation step.

Then we do an analysis of what we've learned from looking at all those different cases to understand, well, what are the key drivers to vulnerability. That can motivate new options. And after you do successive iterations, you can ultimately end up with a tradeoff analysis, looking at how different groups of options perform across those large ensembles of futures, and that helps identify robust strategies.

So, let me just talk through this methodology with the Colorado River Basin Study, as an example, and then I'll be done.

So, one of the things we like to do in the

scoping exercise is really spend some time distinguishing between things that are out of our control and things that, potentially, are within our control. And we use a framework we call XLRM, to organize our thinking.

The way to look at this, briefly, is in the upper left, these are the factors that are the uncertainties. These are the things that are generally outside of our control that we're trying to prepare for. And so, this study developed six demand scenarios, coupled with four of what they called supply scenarios. But, really, those were made up of over a thousand different potential sequences of hydrologic flows that were derived from many of those global climate models that Dan Cayan introduced earlier, this morning.

We also looked at a couple of different ways we might operate the system.

So, that's the future, that's the uncertain future that we're trying to prepare for. There's a lot of -- you look at, you know, the potential water supply/demand imbalance across all those futures and you get a huge range.

So then, how are we trying to meet those gaps? Well, we looked at 40 different options to reduce demand, or augment supply, and we came up with a process

to combine those into different portfolios so we could evaluate how robust they were.

In terms of how we evaluated the performance of these options and strategies across these futures, we had quite a bit set of performance metrics. I'm just going to focus on a few related to water supply and demand. But we did look at electric power and energy metrics, recreation, ecology, et cetera.

And the basis of the analytical work was the Bureau of Reclamation's Colorado River Simulation System.

So, we looked at the case generation. We developed thousands of scenarios and evaluated the system under those scenarios to understand what's the scope of the problem and then analyze for vulnerabilities.

Okay, so the vulnerability analysis, what is that? Well, it's looking at all the outcomes and saying, well, what are the key drivers? Is it population demand? Is it single dry years? Is it multiple dry years? Is it temperature?

And through this analysis, we identified, you know, there's a wide range of outcomes. And what this is showing is each dot here is a single simulation of the system, under a single set of plausible conditions.

Anything that's red is one where we have a vulnerability in the Upper Basin, so that the amount of flow that's flowing between the Upper Basin and the Lower Basin is insufficient and would trigger shortages.

We're showing these results in terms of two key parameters that seem to explain a lot of the vulnerability. And they're not unsurprising, but what we've done is been able to identify the thresholds. And those are, you know, sort of the mean annual flow through Lee Ferry, so from the Upper Basin to the Lower Basin. And then, a determination of how long the critical -- or how deep the droughts are in those time series.

And what we find is that for the Upper Basin we really need -- we're looking at the conditions that stress the Upper Basin portion of the system are conditions that are drier than have been in the past, both in terms of the mean and in terms of the depth of the dry period.

But there are a lot of plausible conditions where we have, you know, essentially compact calls. So, there's insufficient water going from the Upper Basin to the Lower Basin, which causes significant curtailment in the Upper Basin.

In the Lower Basin side, we have results that

are even more dire, which shouldn't be that surprising, given the state of Lake Mead right now.

In this case, we have conditions which only have to be slightly drier than have been in historical. And you can see many, a vast -- you know, almost about half of the cases we looked at, we're seeing conditions where Lake Mead is dropping to a dangerously low level and triggering shortages.

So, what this information tells us is, okay, we have a problem and lots of potential futures. We kind of understand the key drivers. Now, let's begin to piece together solutions.

And so, this involves the iteration back up to the decision-structuring stage, where we start thinking about, okay, what are some ways to close this gap, and then we can begin to understand the tradeoffs among them.

So, we developed a procedure, you know, the study team developed a procedure to combine quantitative analysis with stakeholder expert judgment and preferences to think about what pieces of water management strategies can we put together to create a comprehensive solution?

And so, it involved looking at a wide range of options, then doing some preliminary analysis of cost

and yield. Then, putting that together in a decision support tool in which the stakeholders could talk about different kinds of strategies they wanted to test out, and then the tool would help identify the most cost effective ones within that set.

And through that, we developed four different portfolios of strategies. And, actually, in subsequent work we've done some workshops where we've actually developed many more, using other computing facilities to help us test more.

And so, from this set of strategies we can then understand, okay, well, how do these perform in reducing resilience and then how do they compare.

All right, so what we do is we evaluated all of these different strategies. I'm just going to go through, quickly, some of the key results here.

One of the things we see, when we look at all four of these portfolios in terms of Upper Basin vulnerability, that's the panel on the left, and Lower Basin vulnerability, that's the panel on the right, we've characterized those futures that we determined that were really stressing.

And we said, okay, in those stressing futures, you know, for instance the declining supply is a stressing future for the Upper Basin, and the low,

historical supply is the distressing condition for the Lower Basin. We say, well, how do these different portfolios perform in terms of total annual cost along the X axis and percentage of the years that remain vulnerable across all of those futures.

And we begin to identify that, you know, portfolio C, in which we're focusing more on transfers and less on specific investments in the Lower Basin, they tend to perform better in the Upper Basin. And, specifically, portfolio B performs better in the Lower Basin.

But one of the things you can see is there's a lot of cost involved and these tradeoffs are significant. You know, the differences between one portfolio and another portfolio can be the difference between 7 billion a year and 3 and a half billion a year.

So, these are big, big decisions. Now, we're recognizing that we're not going to go and do $7 billion a year of investment tomorrow. So, the analysis looked at, well, what constitutes, you know, a robust set of near term options today?

And so, we're looking across -- so this graphic, it's got a lot of information on it, but the patterns are what's important here. And what's shown here is a

list of all these different options that we analyzed. And the simulations told us how frequently they were needed in any given simulation. And this is telling us how often those options are implemented in order to reduce that supply and demand imbalance.

And so, what we see is options on the top tend to get implemented sooner in the simulation. And by the time you get to 2060, at the end of the study period, they're implemented in every future. Even those futures where it's rainier, or those futures where it's not quite so dry or hot, you still implement them.

And so, these are options that we know we're going to need to take. Any option where it has really dark red, on the right-hand side, so these are things like ag conservation, M&I conservation, some groundwater projects, watershed management. Those are projects that need to happen, they need to happen soon and can really -- and the Basin and the Bureau recognizes those as sort of keystone, you know, strategies to begin implementing, now.

Then when you get down, further down on the list, when you start thinking about some of the de-sal, you know, some of the further increments of conservation, in many cases they're really needed, but in other cases they're not.

And this -- I mean, this clearly identifies why it's so important to develop these strategies in an adaptive way.

So, this kind of information has, you know, from the study, led to the creation of additional working groups, where they've looked at -- well, they're looking at and they're just finalizing their recommendations on ag conservation and transfers, M&I, and watershed management.

So to wrap up, what that kind of analysis helped us do is hone in on what we need to do now. Even though we didn't come to any conclusion on how the climate's going to change, or which demand projection is the one that's most likely, what we did come to is an agreement that this set of actions is critical, now. And then, we need to keep working towards figuring out ways to reduce vulnerability that's going to continue to persist.

So, this is just a picture of the reclamation publication and some of the key benefits of using this kind of methodology and this planning approach. So, helped organize stakeholder values and opinions on the topic, identify key uncertainties, structure the design of adaptive strategies, and then highlighted some of the key tradeoffs and identified near term actions.

We have a couple of reports that you might find

interesting, where we show some of the tools that we developed, and hone in a little bit more on the methodology. And that's all available on the RAND website.

And with that, I think I will conclude and maybe I can borrow a few minutes for questions, if there are any. And here's the source of -- or our website, if you want more information.

So, thanks very much for your attention.

(Applause)

CPUC COMMISSIONER RANDOLPH: Thank you, very much. Do we have any questions? Okay, thank you.

DR. GROVES: All right, thank you.

CPUC COMMISSIONER RANDOLPH: Okay, we're up for our next panel before our lunch break. Kristin.

MS. RALFF-DOUGLAS: Thank you. We've asked everybody to come here and talk about very big topics and given them a very short period of time to talk about them, and I apologize for that.

Our next speaker is Kathleen Ave. She is the Climate Program Manager at SMUD. And so without further ado --

MS. AVE: Thank you very much. Good morning, everyone. Thank you very much for having me on this really great agenda. I know that at some point here,

every word I say will start to sound like sandwich, so I'll try to move it along and get you what you need.

So, I guess, I'm the practitioner for the morning. Kristin asked me to talk about how we're using our readiness work to support the community that we serve and integrate more with the community. So, that's what I'm going to be talking to you about today.

I'll just give you a little background on our readiness effort, although I'm not going to get into details about what it says in terms of the findings, the physical findings. But, rather, again, how we're using it as part of regional and industry collaboration and our own Climate Readiness Collaborative in Sacramento.

I'll talk to you a little bit about some example projects and funding needs, if we have time.

But before I start in any of that, I wanted to make a really clear statement that we believe that our work in climate readiness in no way diminishes our commitment and support for our mitigation efforts. Our overall intent to, and continued commitment, to reducing our greenhouse gas emissions.

Our board target is to be at 10 percent of our 1990 levels by 2050. This shows you that trajectory. You know, climate readiness is an additional element of what it means to be a leader in climate, as a utility.

It is not a giving up or giving in, just an important additional focus area.

So, moving on, because there a lot of ways that we could do this -- if this would work. Whoops, that's too many.

Anyway, so this image, thank you, this is what we don't want to happen as a result of our climate readiness work. There are a lot of ways that we could do this and there are dollars that we will spend. We could spend them on hardening our own infrastructure and we are. You know, lots of spending on elevating things, just general strengthening to be prepared for more peak loads, more extreme events.

But if we don't move our community along with us, then we have no one to serve power to in the event of some of these major events.

So, this is definitely not our objective. The other part of that is that as we harden, that type of work can have some really severe unintended consequences. We harden ourselves and we could end up inundating some of our neighbors, and that's not what we want.

I got this image when I Googled the words "island unto themselves". And it came from a video game. And it was reviewed by this gentleman, Daniel

Neville, who's from Australia. And the words that he used to describe this, I thought were particularly relevant.

"The way I lost my health over time, that I became weaker with each battle, made me rely more on my sill than any silly piece of armor or potion. The leveling up" -- a videogame term -- "must come from within the player. Skill is not a matter of more loot, but of patience and smarts."

I thought that was very relevant. I take a little issue with the loot part. We'll talk about that later because I think we do need more. But we also need to spend what we have more effectively, with a little different lens. And we'll come back to those three items, patience, smarts and loots in a moment.

And then the final point on this is that this work really is different than our emergency response and disaster relief type work. We have a great emergency response planning department and Jeff Briggs, who runs it, would be the first one to tell you that that work is generally focused on short-term needs. They don't look out very far for infrastructure planning. So, that's really what this work addresses.

Okay, so what have we done in the past? This work, for SMUD, started back in 2009, when we were

working on implementing AB 32, or planning to implement it. We did a chapter on the physical risk of the climate change that we expect, not just in our service territory, but all the places where we generate power and through which we transmit it.

And then, we began working very closely with our community. We assisted with the development of county wide greenhouse gas emissions inventory, and then some cost benefit analysis on mitigation measures.

And then, in 2013, our board approved our climate readiness strategy. And so now, the findings and climate changes, physical changes are tracked as one of our enterprise risks, along with all sorts of other strategic, and external risks, and financial risks.

And we use this document in all of our long-term planning efforts. That's anything that looks out over five years.

They also agreed that we needed to conduct additional R&D in areas that were more uncertain than others. Wind is one of those, as well as wildfire. And then, they also directed us to participate in our Community Collaborative, and to update this scientific work on a four-year update cycle, which we'll be doing starting again next year.

And so, we call it our readiness strategy. And

I wanted to include this slide so that we could talk a little bit about this, why readiness?

It turns out that adaptation is not a term that is very well understood by the general public. Resilience isn't, either. And this is the research that we used to draw that conclusion, a study that was done by ecoAmerica, with other partners.

At the time we were doing our work, the State was apparently considering preparedness and readiness, and we went with readiness. And then, they went with safeguarding California, so you can't win.

But this is important for any entity that deals with the public and has to help the public understand what this all is. They need to -- it needs to be clear. So, we felt this was important enough to rename our work. And we'll kind of try to stay in tune with that, as things go.

Preparedness, apparently, was the one that tested the best. Non-resilience, even though a lot of things you're hearing today do use that word, this was a set of focus groups and then a survey, and resilience didn't even make it out of the focus groups. You know, it's a beautiful word, but people don't understand it.

So moving on, why do we prepare? It's to assist our workforce and our community of customer owners, for

all the changes in climate and weather that are -- some of which are already happening, and to enable us to manage those risks and help prevent unnecessary risks.

Okay, so we are in the middle of a major transition. At SMUD, it feels like everything is changing today. And this is not just our infrastructure, it's our business as a whole.

There are some big changes happening, we call it SMUD 3.0, or the idea of customer value creation. Our CEO, Arlen Orchard, convened a Community Value Working Group to really understand what it means to deliver value to the community.

Our sales force is undergoing a major change in how they approach their customers.

And then, as you all know, we're in the midst of a major transformation in the energy markets. And so, we are working really hard to prepare for that. All of the initiatives listed below, our Sustainable Power Supply Objection, RPS, our energy efficiency work, electric vehicles, especially our Distributed Energy Resource strategy, really, really key to that.

Our board has made a decision, they do not want to be a poles and wires company. They want to be a full service energy provider. And that will entail the development and the use of a lot of new, emerging

technology, all of which is a great opportunity to insert this awareness of climate readiness and affect that capital spending so that it helps to get us farther down the field.

So, I talk to engineers. I talk to folks in our distribution group. I talk to folks in our budget office, our treasury office. This is not just about what's in the field, but planning for it and planning for the dollars for it.

And we also got this data, I just wanted to share this, from our community partners, as part of that Community Value Working Group.

We do have a great reputation in the community, but there are opportunities to improve that. And a lot of our customers say that they would like to -- that their needs are not just always related to energy and electricity, and in order to serve them better we should be addressing those things. And then, also, that their needs are dynamic and unique. And I think that's just going to continue to change as the climate changes.

So, moving on to how we can do this more effectively on a community basis. This is a map of the participants in an event that was sponsored by the Institute for Sustainable Communities, back in October. And so, there were collaboratives that attended from all

over the country. And California, as you can see, was well represented. There are five organized collaboratives here, in California. I think Louise is going to talk a little bit more about these. And they had representatives there.

They're very diverse in terms of how they're governed, the issues that they address. Most of them have a research component, a policy component, education, outreach and advocacy. But they really do reflect the needs of their own communities.

And I will say, and I'm not saying this to toot SMUD's horn, that I was the only representative from a utility at this event. And I don't like that because they gang up on us when there's only one.

But these are emerging, now. There's a lot of momentum behind this regional organization. And they are emerging as important venues for planning. And if utilities aren't at the table, you know, that creates obstacles for us.

There are also really big opportunities, like I said, to help bring the communities along and ensure that we're not the only ones doing this work. So, these are really important.

This next slide, Craig showed you this. This is the map of the DOE partnership, of which we are a part.

And below it is a map from the Healthcare Climate Council. And so this, I was struck by how similar these are. This is organized by a group called Healthcare Without Harm. And these are really important allies for us in the public health aspects of the work that we're doing.

And they could potentially be sources of funding because nonprofit healthcare systems have community benefit funding streams, similar to public goods dollars. And now that Obamacare is in place, I've been told, I'm not an expert in this, but I've been told that those dollars could be available for things like cool roofs, and energy efficiency, and things like that. So, really natural partners to pull into community level work.

So, this is a view of the Climate Readiness Collaborative in Sacramento, the Capitol Region Climate Readiness Collaborative. It was spearheaded by Larry Green, who's the head of the Air Quality Management District in Sacramento. He runs on renewable energy, for sure. He's a very energetic guy.

And he worked with the Local Government Commission, Kate Meis and Amber Mace from the UC Davis Policy Institute, and Julia Burrows at the time, from Valley Vision. They were kind of the keys to

spearheading this.

And you can see the membership is pretty diverse. We joined very quickly. PG&E has also been involved. And we're in the process, now, of signing up local jurisdictions and reaching out more to the private sector, as well as the healthcare sector, to expand the membership.

And these are the goals of this organization, protect and strengthen the region, build a network for cooperation. Really, a foundation for doing cooperative work to understand the interplay between all the different sectors and really help all the members identify funding opportunities that we could seek.

These are some of the projects that we are doing. Valley Vision spearheaded this Capital Region Business Resiliency Initiative. It's targeted at small businesses.

They did a study on the impacts to the water sector. We're just about to launch, I'm hopeful, a kick start in our Cool Roof Incentive Program, a doubling of the incentives and some targeted outreach to try to get the cool roof industry going in Sacramento.

And then, there are civic spark assignments throughout the region that have been sponsored by the collaborative.

So, the region really -- this is a forum for the region to answer questions like this together, as opposed to just in isolation. What are the best practices for addressing climate challenges? How will we deal with storms that are going to be increasingly frequent? How should we plan for growth and development? You know, what is the value of different types of infrastructure?

And this one is interesting considering, you know, what Craig said about the difficulty in assessment benefits and then what David said about all the uncertainties. The community really has to define what does success look like?

Are we talking about just coping with these conditions and new, extreme events? Are we talking about building protection? Are we talking about building more capacity to bounce back from these events? Or are we talking about trying to expand our definition of health and vitality in a community?

Lots of different possibilities there. And the idea is that at some point, and I stole this material from Suzanne Moser at Stanford, the idea that, you know, over time your options will evolve. You know, in the beginning, this is the case of sea level rise. You may enforce certain setbacks. At some point you may build a

sea wall. At some point you may build a higher sea wall. And then, at some point, you may engage in managed or unmanaged retreat in some continuum.

And so, how will the public interpret that, you know, when the investment that was made in that initial sea wall fails? Will they turn around and say, well, you should have done XYZ? It's going to be really important for us to explain why we did what we did and, you know, decide what the right pathway is.

So, getting into the idea of collaboration across sectoral lines, I like this quote from Geoff Colvin. He spoke at the recent American Public Power Association national conference.

"Organizational culture is what people do when no one tells them what to do."

And in most cases for us, those of us who work in utilities, we work in our little silos. And this kind of cross-sectoral collaboration is really not the norm. It happens, but it's not the norm for us. And so, projects that utilize it really do feel like heavy lifting.

This is an example of some of the ones that we've done at SMUD. This is a co-digestion facility that was built at the wastewater treatment plant. We have a long history of collaboration with them. We buy

biogas from them, they sell us steam -- or vice-versa, sorry.

The project down -- well, up above the AB 32 water and energy assessment, we used some of our greenhouse gas auction revenue to fund a study with the Regional Water Authority. Great collaboration there to identify the embedded energy in our water supply, which is about a megawatt hour per million gallons, just FYI. And that doesn't include wastewater.

The project below was a collaboration with Caltrans to attempt to build PB and CPB on the highway right of way. That one didn't happen, although it was a great learning experience for this one, which we're working on right now, in collaboration with a couple of private partners, and the U.S. Bureau of Reclamation to suspend a PV system over a canal and, potentially, over a fish hatchery to allow for the hatching to occur. All of the fish have been relocated from the ones here in Sacramento, this summer, because of the drought and heat.

So, these do happen and they are opportunities to leverage our capital investments to achieve kind of broader community resilience goals.

A couple more examples, I know I'm running out of time. This is an example from Refocused Partners. I

love this example because it was very deliberately constructed to address multiple needs within the Community of Hoboken.

So, it's a parking garage, but it also functions as stormwater storage and green space. Up on top is a park and then there's three levels of parking. And then in the bottom is a retention basin. So, it addresses kind of three major needs for that tightly-constrained community.

Refocus Partners undertook this reinvest project, worked in eight different communities around the country, with McArthur funding -- or, excuse me, Rockefeller funding.

And the report from that work is very, very interesting for anybody who is looking for ideas for collaborative projects.

A couple more. The one on the left is a water purification system. It's a demonstration at a museum so not, you know, hardcore infrastructure opportunity. But I liked it because it talks about how infrastructure that has previously been hidden could even be made beautiful, and interesting, and place-making.

And I think as we begin to move down the path of distributed energy resources, and getting more of our generation back into the communities, we're going to

have to be very aware of how that's perceived and make some design decisions around it that we really haven't had to make, when we have places these central, large facilities far away from the population.

Okay, so to funding. The little teeter-totter there has some World Bank data, an estimate that it will cost $70 to $100 billion per year to adapt to a warmer world, that two degrees of warming. And that governments have pledged $10 billion to date. So, we definitely have a mismatch.

And we know that mobilizing private capital is really critical. But there's not a lot of good understanding about these distributed and network solutions, so that's going to be a challenge.

But the fact that you can pull together multiple benefits in some of these projects can generate multiple revenue streams. That parking structure project, I mentioned, got money from the Stormwater Authority, they got parks developer fees, as well as just the input from the private developer. So, those are good opportunities.

And then the notion that co-benefits and the avoidance of risk could be monetized is an option that is also getting some attention these days.

But this is a challenge because as a State,

right now, this kind of is a map that I stole from Local Government Commission. And it shows some of the different splintering of the funding streams that are available for cap and trade funding.

And so, it's really difficult for a community to develop integrated solutions when the funding streams are, themselves, very dis-integrated. So, definitely more kind of consolidation and more thinking and development at a State level about how those funds are brought out into the community will allow them to be used more effectively. Not just for mitigation, but also for adaptation, because those solutions really do have to stretch across sectors in order to really be robust preparedness or readiness solutions.

So, we need, back to the smarts, and patience and loot, definitely expanded utility participation in these regional climate collaboratives.

I think in most cases, in California, I think Southern California Edison and SoCalGas, and I know San Diego Gas & Electric have been involved in the collaboratives in their regions in some way, shape or form. That's definitely a trend that should continue.

We definitely also need new models for that interagency collaboration that address our shared risks and common customer benefits to get us out of that

siloed mode of doing business.

We do need patience because there are significant learning curves when you do that. When you work outside of your own silo, you have to learn a whole new language and that's tough. And it does involve a culture shift beyond just a focus on energy.

And then, we need the recognition that failure will happen. You know, either with a project that wasn't quite ripe, like the Solar Highways Project, or just as the climate continues to change your first iteration of addressing a risk may not be your last one.

And then, finally, related to loot, coordinated funding sources that incentivize this collaboration across regions. New funding streams and financing options, again, I mentioned the monetization of risk avoidance, but also the national capital movement holds some potential there in terms of monetizing ecosystem services. All of which should help us mobilize more private capital for distributed and network solutions that really are a key to increasing our readiness.

And I think that's all I had. What time is it? Oh, not bad, sandwich time.

(Applause)

MS. AVE: Any questions?

CPUC COMMISSIONER RANDOLPH: Thank you very

much. Do you have any questions?

CEC CHAIR WEISENMILLER: Yeah, how much does SMUD spend on planning for readiness and how much does it invest in addressing those issues?

MS. AVE: So, that's a slightly difficult question for me to answer because a lot of our spending so far has been pretty integrated in the operations. We spent under $100,000 on our initial readiness strategy, on gathering all of the data and doing the analysis for that.

And then, we've spent probably on the order of that much more in our wildfire or vegetation management, as well as in our distribution world around flood preparedness, analysis of those risks.

But again, in part of my spending time with our budget offices, trying to intersect capital spending that we're already doing, I'm inserting myself in places where, you know, they haven't set out the welcome mat for me, necessarily. But that's the best way, I think, you know, rather than going out and asking for new money, just making sure that the new money that we are planning to spend considers these impacts and can be modified, slightly, to address them.

So, I don't expect a big readiness budget. I expect big readiness action to be worked into our

existing budget, with some additional augmentation. We're going to identify, you know, new research that we need to do around the area of wind, in particular, which is a big risk for us. Despite what Dan Cayan said, I think, you know, there is the possibility it could improve our wind resource.

There's also the possibility that it could still the Delta breeze, which will have a big impact on SMUD.

So, and there are other areas, too, where we're going to need more resource to perform more research.

CPUC COMMISSIONER RANDOLPH: Any other questions?

Okay, so we are going to be taking a lunch break and we will return at one o'clock for our afternoon speakers. Thank you.

(Off the record at 11:56 a.m.)

(On the record at 1:01 p.m.)

MS. ZAFAR: Okay, we're going to get started, if people could take a seat, please.

My name is Marzia Zafar. I am the Director of our Policy and Planning Division.

First, I would like to thank, again, Kristin Ralff-Douglass and Guido Franco for organizing this event.

This afternoon, we will have two panel

discussions, followed by public comment and closing remarks. We're going to try to free everyone up by five o'clock.

The first panel, which I will moderate, is a window to the ongoing research to identify the current and future impacts of climate change.

We have five panelists. I thought we had four and we were going to have 15 minutes each, but Guido informed me that there was some negotiation. So, here's the timing. And I am somewhat anal, so we're going to stick with the time. Guido has 18 minutes, somehow. And then we have Dr. Bedsworth with 14, Scott Flint with 14, and then 7, 7. And as Guido said, I will -- I'm going to time you guys. At two minutes, I'll just make a mention of the two minutes, so then we can have a 15-minute Q&A session with the dais.

Our first presenter is Dr. Louise Bedsworth, Deputy Director of the Governor's Office of Planning and Research. Dr. Bedsworth will give us an overview of California's adaptation efforts.

Dr. Bedsworth, you have 14 minutes and counting.

DR. BEDSWORTH: Great. Well, thank you very much for inviting me here today. And I will look at my watch so I keep track of my 14 minutes.

I'm very excited to participate in this event.

And I will just provide an overview of what we've been doing at the State on adaptation very generally, really stemming from the Executive Order, but also the work that that builds on.

And then talk about some of the concrete examples of work we've been doing on the ground, as well.

Okay, so I think as we've already talked about quite a bit, but I think it's important to reiterate, is that adaptation, resilience, readiness, preparedness, safeguarding, all of the words we use is part of a comprehensive approach to climate change in California.

And this is really built on three interdependent pillars. One is our efforts to reduce emissions through AB 32, and now the Executive Order for our 2030 and 2050 goals, which ties to our work to prepare for the impacts of climate change that we're already experiencing. And all of this is really built on a basis of comprehensive research that is informing our policies. And that our policy needs are informing our research.

And so, I think these are all three very important pieces that can't really be separated from one another, nor should they be.

So, Executive Order B-30-15 established our 2030 greenhouse emission reduction target, as well as

reiterated our 2050 goal. But it also laid out a very comprehensive set of steps for adaptation and resilience in California. And, of course, that's what we'll focus on here, today.

And I would say, I would argue that this is actually one of the most comprehensive -- has the potential to be one of the most comprehensive adaptation and resilience frameworks in the country, if not the world, if we look at all the pieces that we're talking about implementing.

The first pertains to safeguarding California. The Executive Order also says that all State agencies should consider climate change impacts in all planning and investment. It calls out the five-year infrastructure plan, in particular.

And then it calls on our office, the Governor's Office of Planning and Research, to form a technical advisory group to assist State agencies in implementing this Executive Order.

This Executive Order also, very importantly, brings in that third piece of our comprehensive climate policy and reaffirms the State's commitment to research to support these efforts.

So, I'll walk through the different piece of the Executive Order. Well, just a little bit of a delay and

then I got it confused. There we go.

So, of course, this is the first piece, which is the greenhouse gas emission reduction goals. We have our AB 32 goal, our 2030 goal to get 40 percent below 1990 levels by 2030, and to get 80 percent below 1990 levels by 2050.

So, this is the path of emission reductions that we're talking about. And, of course, the important message here is it's a much steeper decline over the coming decades.

So, when we look at the adaptation pieces, one of the first elements that the Executive Order calls out is the Safeguarding California Plan. And this is California's adaptation strategy.

California was the first state to develop a comprehensive climate adaptation strategy in the nation, and this is in 2009, with the California Adaptation Strategy. This 2014 update, Safeguarding California, came out last summer and was the first comprehensive update to that plan.

The Executive Order calls for this now to go from a plan into an implementation or action, more move from the planning to the implementation and action. So, implementation plans are to be developed and this should be 2015, by September of 2015, so this coming September.

Every sector in this plan is going to have an implementation plan. Talk about what they've done to date and then steps they are taking to further implement what is called out in Safeguarding California.

The Executive Order also calls for Safeguarding California to be updated every three years. And to identify -- in doing that update, to identify vulnerabilities by sector, which is how the report is currently organized, in to nine sectors, but also by region.

And I think this is an important alignment with the regional work that is happening, that Kathleen talked about earlier.

And this work is all being led by the California Natural Resources Agency and, in particular, J.R. Della Rosa, who's sitting right there. And so, a lot of work is happening now.

And then, next spring, there will be tracking -- the sectors will be reporting on tracking their progress back to the Resources Agency.

So, another piece of the Executive Order calls out the five-year infrastructure plan. And the five-year infrastructure plan is developed by the Department of Finance and accompanies each year, or most years, and it has the last several years, the State budget.

And so, the Executive Order says that the five-year infrastructure plan needs to consider current and future climate conditions when evaluating and considering infrastructure investments.

The Executive Order also calls for the employment of full lifecycle cost accounting in making infrastructure planning decisions.

The work on the five-year infrastructure plan is being led by the Strategic Growth Council, in partnership with the Department of Finance, and taking an incremental approach to work with State agencies to develop statements of how their decision-making framework reflects the priorities of the Executive Order, and then moving forward to get into more comprehensive implementation of the consideration of future climate conditions.

We're really exploring, in terms of full lifecycle cost accounting, getting a better understanding of what does that look like? How does that align with current accounting practices? And how are we going to implement that?

So, some of these will come not all at once, but more incrementally.

The third piece that I'll talk about here is the technical advisory group. And so, OPR has been tasked

with developing a technical advisory group to assist State agencies in implementing the Executive Order. We have formed a small State agency steering committee, which has got close alignment with the sector leads for the Safeguarding Implementation Plan, to help scope out what the work of this technical advisory group will look like.

What we've been thinking about is defining, adding more definition to elements of the Executive Order. So, what is meant by planning and investment? What are the opportunities there and how shall we prioritize them? Providing guidance on elements, such as full lifecycle cost accounting.

Also, providing guidance on the analytical framework for thinking about climate change and also thinking about what we should be planning for. So, what are the future conditions we need to be thinking about?

And so, that work is ongoing and we will be forming the technical advisory group either later this summer or in the early fall. And it will include both members of the State, but also members from local government, from the private sector, and from the public. And so, the idea is to form a representative group that is really going to work together to form guidance that State agencies can use to think about how

to implement the Executive Order.

The Executive Order also reiterated the State's principles for adaptation, and these were contained in the Safeguarding California Plan, as well. And I think they are important to just emphasize, because they do guide a lot of the work that we're doing.

And so, it puts the priority on actions that both reduce greenhouse gas emissions, but also help build resilience and preparedness. So, thinking about the strategies that we can use that help us integrate across mitigation and adaptation to the best that we can.

Obviously, we're not going to be able to do this in every case. But the idea is let's take advantage of opportunities, where we can. And I think there are some good examples in the energy sector, such as energy efficiency, water efficiency, where we do -- we are able to get some of those double benefits.

To use flexible approaches so that we can be adaptive in light of uncertainty and change. So, how do we be flexible, while also providing some degree of certainty in the guidance that we provide?

Protecting the most vulnerable in California. So, the most vulnerable citizens, both in terms of location, but also very importantly, I think, in terms

of socioeconomic and other vulnerabilities that make people less able to prepare and cope with change.

And, finally, to prioritize natural infrastructure solutions. And so, this is using, where we can, natural systems and ecosystem services to try to address some of our challenges, either on their own or in combination with hard infrastructure.

And so, that's really a lot of the elements of the Executive Order. And I'll just cover, in the last minute or two here, a couple of things that are happening on the ground, in the work that we're doing, that I think are really helpful opportunities for implementing some of these pieces.

First is a lot of the work that we have been doing with local and regional governments throughout California.

Kathleen mentioned earlier, the Capitol Area Resilience Collaborative. And they are part of a larger collaboration of regional resilience collaboratives around California. So, California has five regional collaboratives that have formed, focused on adaptation and resilience. In the Bay Area, Los Angeles, San Diego, Sacramento, and most recently in the Sierra Nevada Region.

And so this collaborative has been an excellent

resource for us, as we work with local partners, to see the challenges that they're facing, the needs that they have, but then also how that integrates with the work that we're doing at the State.

We've also developed Civic Spark, which is the Governor's initiative under the AmeriCorps Program, which is centered around nine regional hubs throughout California that place AmeriCorps members into communities to help them do planning around climate change, both mitigation and adaptation.

This has been a really successful program, run through the Local Government Commission. And it has just been announced, about a week or two ago, that the national government, the Obama Administration, is going to replicate this program for resilience throughout a set of pilot communities in the United States.

So, this has been a very successful program. And then one that we're looking to integrate more into the resilience work that we're doing at the State level, to help it get from the State down into practice at the local level.

I'll also mention, at OPR we are developing a new, updated set of general plan guidelines for all cities and counties in California. It's the first comprehensive update since 2003. And through this,

we're integrating principles of climate change and climate, both mitigation and adaptation, throughout that entire set of guidelines. So, again, trying to provide guidance to local governments to implement this work.

And, finally, I'll just mention, briefly, work we're doing through the U.S. Department of Housing and Urban Development's National Disaster Resilience Competition, which is a $1 billion competition for resilient recovery following a federally-declared disaster.

The State is working with federal and local partners to develop a program for resilient recovery in Tuolumne County, following the RIM fire. And what we are working around is developing a community and watershed resilience program.

And so, this is really trying to link State goals for watershed protection, both for water supply, but also for energy needs with local community resilience, both through local economic development and investment in communities to boost their resilience through infrastructure and other resources.

And so, this has been, so far, a State, local, federal and private partnership to try to identify the pieces to put together to develop this program in Tuolumne County, that we hope will be replicable

throughout the Sierra Nevada, and all watershed communities in California. And we've even been talking, now, about some other states about, potentially, more western-wide applications.

This is work that we will be submitting our final proposal to HUD in late October, so it's still in the development stages. But one we're also really looking to integrate that watershed resilience into our broader statewide goals and build out our urban and rural connectivity issues, and the importance of a systematic approach to resilience in those watersheds.

And so with that, I will pass it over.

MS. ZAFAR: So, you have your choice of sitting there or coming here.

Next, we have Guido Franco from the CEC. Guido is the Team Lead for Climate Change in our Environmental Research, in the Energy Commission's Research Division. Guido, you have 18 minutes.

MR. FRANCO: Thank you. So, I'm going to talk about research and climate change, and adaptation. First of all, I want to thank for the opportunity to give this presentation.

I'm going to start with some background information, then I'm going to give some examples of mitigation -- I'm sorry, about potential impacts and

adaptation options. Then, I will briefly describe some forthcoming studies, and then I will conclude.

Okay. Supporting any of related climate change research, the Energy Commission started working on climate change in 1988. But we started in earnest to support research in the early 2000s, with the creation of the Public Interest Energy Research Program.

The vast majority of the studies that have been done for California in the energy sector come from the PIER Program. The PIER Program, as you may know, have ended. But now, we have the EPIC Program. So, we're starting to support any related research on climate change to the EPIC Program.

We also receive funding for the PIER Natural Gas program and we have funding to start looking at potential impacts of climate change to the natural gas system.

CPUC has been a key player in all of our work. As you know, the funding for example, where the EPIC Program comes from the CPUC. We have been blessed to have, as a partner, the CPUC working with us.

One thing that is not indicated here is the fact that we used to have annual conferences on climate change. They were very popular, very useful. A new set of climate conferences is going to start this year,

August 23rd and 24th. So, we invite all of you to come to Sacramento. I think you're going to find it worthwhile to attend.

So, let's start with some examples of potential adaptations, some impacts. So, let's start with hydropower units. In general, we divide hydropower units in California in two sets of -- or two types of hydropower units. One is associated with large reservoirs, like Folsom Dam. And these low elevation hydropower units provide about 25 percent of the hydroelectric generation generated in California.

But their main function is not to provide electricity. They are designed for flow protection, for water supply and for recreation. Electricity in the nation is the secondary benefit that we get from them.

We have funded multiple studies on this. I'm just going to mention the latest one was the developing of an assistant that we call INFORM, that utilizes a modern decision support system with a probabilistic hydrologic forecast to help us manage our water reservoirs.

It has been used in a demonstration stage showing it's far superior with the way we manage our water reservoirs in California.

And we have used the INFORM system with climates

and that is to see how well the system will also help us with climate change. And the result is that it will also be useful under the climate change.

One of the problems with the implementation with INFORM, however, is that there are multiple actors, federal and state, different institutions that it's very difficult to implement a system like that. There are also some laws that may prevent the implementation of this way to manage -- this modern way to manage reservoirs.

But I just find out a few weeks ago, that the Department of Water Resources are thinking about implementing a methodology like this.

So, the second set of hydropower units are what we call the high elevation units. They provide about 75 percent of the electricity. The snowpack is the main reservoir. They are also associated with some more reservoirs.

We have, again, four to five studies looking at high elevation hydropower units. One of them is shown in the upper right. It's work done by UC Davis. And they show that even if the precipitation doesn't change, because we're going to have increasing transpiration, I mean the transfer of water from soils and plants to the atmosphere, that it will be a reduction of the stream

flows. So, precipitation is a bad indicator of the availability of water and stream flows, in general.

One thing that it wasn't surprising for me, a study done in the Upper American River Project, by UC Berkeley, is the fact that there will be a lot of spillage in the wintertime. But something that nobody has looked is the implication of the spillage into the operation of low elevation hydropower units, because they are interconnected. So, that's something that we plan to study in the future.

One of the things that has made the work less useful has been the lack of detailed information about the hydropower units. I mean, they essentially have used whatever is available in the public domain. But there's certain information that is only available to -- only the utilities have.

So, now, let's look at electricity at high temperatures. I think this theme has been mentioned already, so I just we'll say we're did an exercise, via LBNL, where we superimposed the climate of the future to the infrastructure of the present. And we find out that if we have a climate feature this summer, for example, that we will have needed increase of capacity in the order of 30 or 40 percent, generation capacity because of all the problems associated with increased demand,

insufficiency in thermal power plants, et cetera, et cetera.

And even in the next 10 years, the 2013 IEPR, the Integrated Energy Policy Report, looked at what climate change -- what will be the effect of climate change in the next 10 years. And the result is that we'll need an increase in capacity of 1.6 gigawatts. That's two big power plants that will be needed in the next 10 years.

Now, let's look at electricity demand in the residential sector. I mean, we have been fortunate that utilities share confidential household information data, electricity bills, with UC Berkeley.

Professor Auffhammer used that data to electricity demand at the five number code level, zip code level -- so the research have been identified, the groups that will be disproportionately impacted and also long-term impacts. I mean, I just was reviewing a paper that Professor Auffhammer is publishing. He has used like half a billion, yeah, half a billion datasets to develop this -- to estimate potential impacts.

Demand for space heating. We have not done very much about this, but we should. In part because we also want to know, quantify the benefits in this case of climate change cool days are going down in the last -- I

mean, the last 40 years, since 1960, 45 years. You know, cool days have gone down by 15 percent in the Sacramento -- in the San Joaquin Valley. That's a huge amount.

But what is surprising for us is when we asked people what would happen, with the Scripps Institution of Oceanography, what will happen with extreme events, the cold nights, will they disappear? The answer is no, they will be less frequent, but they still will be present in the future.

The 2014 data point is shown then and it shows that it's very unusual, extremely warm winter.

Wildfires and transmission lines. We funded a project looking at how wildfires will change in the future and then we asked LBNL to superimpose to that the information about -- GIS information about the transmission lines to estimate the increment of risk.

This was done just with that information. We would have loved to have data from the utilities, historical data linking wildfires with great disturbances. I mean, we wanted to develop empirical statistical relationships that will help us develop better estimation of potential impacts of increased risk of wildfires to the transmission lines.

That was impossible but, I mean, we understand

why. I mean, I think the utilities were -- there was a lawsuit against the utilities and we understand that it would be a difficult situation to share information.

Coastal impacts, we -- I mean, the Pacific Institute started a study for us and published in 2009, looking at what energy infrastructures will be affected by sea level rise. In this case we have substations.

But one of the problems that we realized later on is that the GIS data in the public domain may not be correct. Sometimes it's off by 200 meters, 300 meters or more. In part, the reason for that is for security reasons. We don't want to give the exact location of our infrastructures in the publicly available GIS. So, this is an issue.

Sea level rise, well, okay, we have -- now, let's switch a little bit, the topic, and let's move from electricity to natural gas, kind of.

In the Delta, in the Sacramento/San Joaquin Delta, we have very important energy infrastructures. We have underground natural gas reservoirs, we have transmission lines, natural gas pipelines, et cetera, et cetera. And so, it's important to look at the potential impacts of climate change, in this case sea level rise, to the energy infrastructure in the Delta. One reason is that the interior deltas are below sea level.

So, there's a report coming out from UC Berkeley, that will be available in the next few months. They use a dynamic, hydronomic model, very sophisticated type of analysis. So, the report is coming out in the near future. You will find it very interesting.

So, and so sea level rise is a problem. But we also asked Professor Brooks, at that time at the University of Hawaii, now in USGS Menlo Park, to measure subsidence of the levies in the Delta. The levies that protect the islands in the Delta. And using InSar data, satellite data, he found out that the levies are also subsiding. So, they say they're all subsiding in the entire Delta region.

This compounds the problem of sea level rise. Sea level rise is going up, the levies are going down, so the relative sea level rise is moving at a faster rate than just sea level rise, alone.

But satellite data are not accurate enough. Well, we shouldn't say they are not accurate enough. People doubt, sometimes, the use of the satellite, or as we say, WEC, the available portable LIDAR data, because we don't have enough money to fly aircraft all the time. The use of LIDAR.

So, he did it. So, now, he's using the portable LIDAR to measure very frequently, several times a year,

the levies that are protecting the energy infrastructure in the Delta. So, but we'll have a better idea of how fast the levies -- I mean, what geographical pattern the levies are subsiding.

Adaptation opportunities. So, I think for adaptation opportunities, we have started with win/win opportunities. So, I talked about the INFORM project. We have a new project that we selected with the competitive solicitation. It's a project with UC Riverside and NASA. Southern California Edison is working very closely with that group.

So, what UC Riverside and NASA are going to do is to use a modern -- to make a model to simulate how, to estimate in a probabilistic sense, the changing hydrological conditions. That information will be fed to a system support system, developed for SCE, to find ways to improve the management of their hydropower units.

One important thing about this project is that they are considering the role that the small particles in the air have on precipitation. I will talk about that later on.

The other win/win study is micro grids. They reduce -- they can reduce the vulnerability of critical infrastructure. One example is the Borrego Spring.

They just had in May, two months ago, May 2015, a lightening damage to a transmission line. They have to shut down the transmission line for maintenance, for ten hours. The Town of Borrego Spring, I think didn't care because they have energy, they have electricity. I think only for ten minutes that there was the need to reconnect to the grid.

Another type of adaptation study that we're funding is seasonal and decadal forecast, whereby the researchers that we have funded have shown that we're able to predict, in a probabilistic sense, again everything is probabilistic, the temperatures in the next summer. So, four or five months ago we can predict, in a probabilistic sense, the distribution of temperature in the summer.

So, we think there are huge benefits, including the issue of the Delta breeze. We don't have time to talk about that, but it's an important issue and significant progress has been made on that.

What we found out with this is that if we just work with technical people, the work will not be used. We need to reach out to people that can decide and say just do it. If not, we'll have fun, but it's not going to be used.

We're also using Cal-Adapt, and Susan is going

to talk more about that, as the way that we're using to translate our research results, including the seasonal forecast, to electricity -- to electric utilities and all those.

Okay, so let me talk about a topic that I love. It's the role of small particles on precipitation. So, in 2004, I was told small particles in the air would not have an effect in California. It was a famous professor. I say, I don't believe you, so we started funding some research. To make it sure, we found out that aerosol has a huge impact on precipitation levels in California.

We funded a study, CalWater 1, that had one researcher graph, several instruments going around, measuring the particles in the water, and the droplets, and in the ice. And we thought that only emissions from California will affect precipitation in California. Well, actually find out that dust and bacteria flying all the way from Asia and Africa seed our clouds.

This is important for utilities, also, because if the clouds are already seeding by dust, you don't need to seed it. I mean, don't waste your money, they are already seeded.

But it's also important because the seeds have -- I mean, the ice particles have a huge influence,

not only in the amount of precipitation, if you have the dust coming aloft, the precipitation can be 40 percent more than normally. But also in the form of precipitation. The ice seeds produce snow, instead of rain.

So, the work resulted in a paper in science, a backbreaking study. It's so backbreaking that the federal agency decided to do it again. And five research aircraft, multi-million dollars, the research results are forthcoming.

Transformation of the energy system, the Chairman told us use the -- at least that's my understanding, that look at the transition to a low carbon energy system as an opportunity to also develop a system that is less vulnerable to climate change. So, we're working on that. That's a project that's just started with three major research institutes in California, and we will be doing that. So, basically, we're combining mitigation and adaptation.

Planned studies, the California Fourth Climate Change Assessment is forthcoming. I think I don't have time but, well, you know about that.

Partial list of studies, let me see -- well, we will have studies on all of these topics, so thank you very much.

(Applause)

MS. ZAFAR: Thank you so much, Guido.

Next, we have Scott Flint, also from the California Energy Commission. He will be discussing the Desert Renewable Energy and Conservation Plan, 14 minutes.

MR. FLINT: Thank you. So, I wanted to switch gears just a bit and talk a little bit about planning and implementation of a plan related to siting renewable energy in the desert portion of California.

So the example today is the Desert Renewable Energy Conservation Plan, or what is known as the DRECP. This is a four-agency effort that was co-led by the California Energy Commission and the U.S. Bureau of Land Management to plan for energy in the desert. And we were also joined by our partner agencies, the California Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service.

So, overall, the plan does two things. It helps California -- well, it helps California and the nation implement renewable energy and greenhouse gas reduction goals by doing two things.

One, helping guide and plan, as a climate mitigation strategy, the rollout and deployment of large amounts of renewable energy within the State. And at

the same time, implement a biodiversity-oriented landscape conservation strategy, which also helps achieve other California goals of sensitive species, and wildlife, and biodiversity protection.

So, it's both a mitigation strategy and an adaptation strategy, and both of these strategies are important to manage into the future from a climate change perspective.

I want to back up just a second. Just to give you a brief overview, you'll see this on several maps. We were talking about the planning area was 22 and a half million acres, the entire desert area of California, and a little bit more. And I just wanted to orient you so you can see where you are. You're in the eastern part of the southern part of the State on future maps. About 22 million acres. Ten million acres of that owned by the Bureau of Land Management. So, indeed, that's why they were such an important planning partner.

So to do this effort, what did we have to do? Looking out on the conservation side, from developing a plan-wide conservation footprint that took into account natural communities, sensitive species, and ecosystem functions to protect those on the landscape.

On the energy side, identifying areas of lower

conservation value or biological value that would facilitate and be appropriate for development to ease our permitting and siting capabilities and be able to move fast to get the projects on the ground.

Those tend to be the already disturbed areas, outside of the areas important for conservation.

And we also had to identify -- in that case, we had to identify areas that had appropriate renewable energy resources, both high value wind and high value solar, and were near the -- at least near or able to bridge to the existing transmission system. So, those were important considerations for the development side.

So, the DRECP, the Desert Renewable Energy Conservation Plan, took those two footprints, the conservation footprint and the plan-wide energy development footprint, and put them together into a plan.

That plan was released in -- the draft was released in September of 2014. After extensive public comments, the DRECP is now going forward in two phases. The current phase, going through the end of this year, will be the completion of a land use plan amendment, by BLM, to lay out the development areas on federal, BLM-owned lands, and the conservation areas.

At the same time, the CEC and the wildlife

agencies continue to work with the counties and other local agencies, who are doing comprehensive general planning with some grants from the Energy Commission, to look at elements for both renewable energy and transmission and conservation.

So, we're now spending a little time on the private land side, working with the counties to incorporate their general planning.

So, one of the key features in the strategy and something that implements, for this area, one of the goals of Safeguarding California, is a comprehensive linkage and connectivity design in the desert. Well, that's a key feature of this plan on the conservation side. It also follows basic tenets of conservation biology, where you look for large areas of intact landscapes, natural landscapes, and then make sure you connect them with appropriate habitat. So that species that have lived in and move through corridors between their various habitat areas.

So, since we've published the draft, a recent paper, published in *BioScience*, of March 2015, has recognized the climate adaptation benefits of the DRECP's linkage design.

And they site three points. One is by having this comprehensive, overall network of connectivity, we

are avoiding significant uncertainties in the modeling by identifying all potential corridors and assembling them into a coherent design.

Secondly, the corridors link what are existing habitats today, what are likely to be habitats in the future under different climate scenarios.

And, thirdly, this blended approach should work under a wide variety of climate futures.

So, it's no surprise that it worked out that way because one of the things we did was look at some climate modeling. We looked at the latest climate modeling from the IPCC modeling in 2013-2014, and worked with the Conservation Biology Institute to examine that modeling and then do some additional modeling for us in the DRECP area.

And we did this to ensure that we were selecting the right lands that would be resilient in the face of climate change for those species.

So, we ran 20 different models or looked at 20 different models. And then we picked three models, a wetter one, a drier one, and a kind of in between one to look at and examine, further, in the DRECP effort, because we were looking at a wide variety of different futures. One wet, one dry, and something that looked like, everyone agreed, was on a trajectory that was

agreed -- agreed upon by a subset of the existing modelers.

So, in doing this, we generated about 450 datasets, just for the 20 climate models. And those are available on Data Basin, which is an existing and operating data platform that Conservation Biology Institute has developed over time, so that houses the data.

And in just picking the three models to focus in on, with additional modeling for the DRECP area, we took those models and worked with some additional vegetation response modeling. We worked with fire modeling. And we worked with -- and we worked with fire modeling. And we worked, primarily, with those two to look at the effects that fire might have on managing these lands into the future, and also how vegetation may cycle.

And then, of course, potential for invasive species issues to become worse in the desert areas. Those will be long-term management issues to address in ensuring conservation is in place going forward.

So, in those three models we have 150 datasets. So, we got it down from 450 to 150, but it's still a lot and it's hard for folks to understand what we're doing, and how those models work.

And part of this planning effort is

communicating to the general public what is the data behind the plan, what's driving our decisions about identifying certain areas as necessary for conservation or available for development, and being able to communicate that to the average system, and decision makers at all levels of government. And, to some more sophisticated stakeholders. So, that's been quite a challenge.

So, throwing all the data up there and saying, hey, go for it, isn't quite the best way to do that.

This isn't the right set of slides. Sorry, I was going to show you this live, but because of technical difficulties, limitations of the room, not of the Climate Console, I'm not going to be able to show it to you live today.

But to better show, allow people to access that data and see what's going on with that data, and support decisions, and then for practitioners, as myself, and other agency folks to develop different scenarios and show the public how we made those decisions, we developed this DRECP Climate Console.

So, you're seeing that slide here on your screen. So, I know it's hard to see and it's not interactive, so it's not going to be as fun as I planned, but we'll do it anyway.

We have here, on the right there -- on the left side of the screen we have your map of the DRECP area. We're zoomed into that, now. And what you'll see there is you have several different ways, when you go in the console you can pick different sets of different divisions or subdivisions to look at the data.

So you would see, on the left side you can pick watersheds, you can pick the ecosystem subdivisions. And that's what you're seeing there, that we used in developing the plan.

On the right side, you see the modeling results at the top. So, you see in the first column these little dots here. In the first column you're looking at temperature, and you're looking at historic temperature, that first dot.

The second set of dots is the models for the 2016 to 2045 time period. And the three different dots are the three different -- are two different models, the wet and the dry. The wet on the top, the dry on the bottom, and the ensemble of those two.

The third is the same model outputs from 2046 to 2075.

So, when you're in the site, you can interactively click on those different models and this map will change dynamically to show you the model result

in the whole area. And focused on the area you picked, you will see the averages, average annual temperature, in this case, would return for the area that's selected. So, this area here.

So, the numbers right now, that you're seeing, related to that area selected.

At the bottom we have, also have interactive set of indices that were developed. We have climate exposure, potential climate impacts, and site sensitivity are three of the indices you see modeled at the bottom for each of the time periods. And then we also have a separate dataset that tells us about terrestrial intactness, or the intactness of the landscape that you can see here, also.

So, those bars are live. You can go to those bars and click on them, and you'll see the map populated with the different site sensitivity indices that are there, and it will change dynamically as you click.

And so, I encourage people to do on the site and play with this, when it's available. It will be available in mid- to late-August. And right now, it's tuned to the DRECP area. It's basically there to show us the results of the modeling and the results of the conclusions that we got from that modeling for the DRECP area.

What's next for this is to expand it to an effort that the CEC has going on right now, in the San Joaquin Valley, to identify low-conflict solar sites in the San Joaquin Valley, and then to extend it statewide as a more capable tool for planners and practitioners to really drill in on the climate change modeling, and work with it in different areas.

And we are also setting it up and designing it to compliment Cal-Adapt. And we'll hear a little bit more about that in a minute.

Thank you.

(Applause)

MS. ZAFAR: So, next we have two speakers sharing the same topic and I will introduce both at the same time. The topic is science and tools for understanding coastal vulnerability of energy facilities.

We'll start with Dr. Susan Wilhelm. And Dr. Susan Wilhelm manages energy-related environmental research, with a focus on issues related to climate change and public health.

Followed by Dr. Li Erikson. Dr. Erikson is a research oceanographer with the USGS Pacific Coastal and Marine Science Center, in Santa Cruz, where she has been working since 2005, focused on hydrodynamics, near shore

processes, coastal flooding and shoreline change. So, 14 minutes, 7 minutes each.

MS. WILHELM: Great, thanks for the introduction. I'm going to offer you a brief overview of State mandates, sea level rise guidance documents, and tools that relate to adaptation and sea level rise planning.

And then, I'll hand it over to Dr. Erikson to give us a tour of Our Coast Our Future.

We've already heard a bit about the Governor's recent Executive Order which, in addition to establishing groundbreaking, mid-term emission reductions goals, also establishes a framework for comprehensive adaptation planning and implementation.

The other State mandate I'd like to mention is AB 2516, which was passed in 2014, and requires the State to create a publicly available sea level rise planning database.

And this database will be available in early 2016. It requires a number of entities to provide planning information that relates to sea level rise. And the entities include the Energy Commission, IOUs, POUs, and natural gas utilities.

Okay, so two State guidance documents I'd like to mention. In 2013, the Ocean Protection Council, in

an effort to try and get State agencies to use consistent bases for sea level rise planning, update a sea level rise guidance document to incorporate best available science from the National Academy's report.

One thing I'd like to point out is that although this 2013 update is best available science, the uncertainty bands for the various time horizons are rather wide. And it does pose, still, a challenge to decision makers.

The other document I'd like to point out is the California Coastal Commission's draft document that is currently in public review, and will be heard by the Commission in August.

One thing -- this basically provides methodology for Coastal Commission planning and regulatory actions.

And one thing I would point out is that it recommends the use of a 500-year flood event for coastal, for critical infrastructure. And it also suggests that all power plans, all coastal power plants are critical.

Okay, so a number of tools are available for exploring coastal vulnerability in California to sea level rise. These tools differ with regard to the models they use, the level of sophistication, the types of analysis, and also the geographical resolution.

I just want to say a few words about Cal-Adapt, which the California Energy Commission has overseen the development of. Cal-Adapt presents a very easy, user-friendly way to look at local climate-related risks, including sea level rise.

Currently, we're working on version 2.0, which in addition to updating the downscaling data to align with the IPCC's Fifth Assessment Report, and improve resolution will better capture distribution of precipitation, as well as temperature extremes.

The other thing to note, with regard to version 2.0, is that it will allow third-party users to create custom tools, so that they can manipulate the information on Cal-Adapt for their own decision-making purposes.

The other tool that Scott already told you about is the Climate Console from Data Basin, that will be released later this summer and we are working together to coordinate those tools.

Data Basin, though, as Scott mentioned, is more tailored towards planning and conservation efforts.

So, now, I would like to hand it over to Li to present on Our Coast Our Future. Thanks.

MS. ERIKSON: Thank you. So, as Susan pointed out, there are several tools available out there for

assessing sea level rise impacts on our coasts.

Let me see if I can test this, as well. Yes, okay.

So, one of the tools that we've developed and made is the OCOF tool. So, OCOF is actually the tool and CoSMoS is the model that we use. I'll talk a little bit more on the differences between CoSMoS model and other models.

So, OCOF, Our Coast Our Future is really what it stands for, is an interactive tool that can be used to explore multiple different scenarios, including king tides, waves, currents. It can visualize all of these things in your particular area of concern.

CoSMoS is the Coastal Storm Modeling System, the model system that we put together at the USGS, with the aid of other researchers, as well, Del Torres, and Scripps, and so forth. Results of this model are then used in the OCOF tool.

And, currently, it's available for the San Francisco Bay Area, as you can see here on the image, from Bodega Head to Half Moon Bay, along the outer coast, and within San Francisco Bay, as well.

And we are currently modeling further, as we speak, so we're currently working on the Southern California bite. And the first set of scenarios are

coming out this September. And then we'll be completing with the rest of the scenarios this time next year, they should all be available.

And we'll also doing the Pt. Arena extension, so we're going a little further north. And we probably will be continuing to fill in the rest of California is what it appears to be.

So, what makes CoSMoS different from other models, or so unique? In this case, we're using an explicit deterministic modeling system, so we're numerical models that we model all the relevant physics. And we're trying to keep it as consistent as we can throughout the State.

When I say all the physics, we include waves, tides, sea level rise, ANSO (phonetic) effect, so the changes in water levels that occur just with long-term changes, seasonal effects. And then, we put them all together in numerical aspect so that they interact, occurrence and waves interact and both things change as sea level rises, as well, so it's not just a linear superimposition.

Additionally, the wave climate that we developed is from the latest suite of the CMIF 5 (phonetic) models. That's the latest round. And they're modeled globally and then brought down to a local -- to a

regional and then a local scale. And we, as well, include the atmospheric pressures. And we bring all that down to the parcel scale.

And the last bullet point up there is that we -- the scenarios feature the full spectrum of sea level rise, so all of those combinations from 0 to 2 meters, at .25 centimeter intervals, and also an extreme 5 meter sea level event. And on top of that, we have the combination of different storm events that we've extracted from the future time series. So, not hindcast.

So, I was just going to go through some of the OCOF tool to show you kind of what can be done, how you can get the data, how you can visualize it, how you can look at it. Because as I was saying that, you know, we have the data, okay, but now we need to get it out there for users, stakeholders, planners and managers.

And so, we worked with Point Blue to develop this site, which you can find if you just Google OCOF. And you can zoom in on specific areas that we have completed.

And what you can see, I think, over here, I can't see it from there, is on the left-hand side we have -- you can choose your topic, flooding, looking at flooding, waves, currents, duration, flood potential.

I'll go into that a little bit. And you can choose your sea level rise from 0, as I said, up to 500 centimeters. You can choose your event.

And on the bottom here, what the arrow is pointing towards, is that it's also overlaying with GIS levels, layers. So you can, for example in this case -- well, if you -- these are all the GIS layers which you can't read, I'm sure, but it gives a little description of what they are.

So, we have utilities and services, roads and transportation are all brought in there, as well. And since is for the energy, what we've -- what I did here is extracted a small section up in Richardson Bay. And I think the next one, yes. We zoomed into Richardson Bay in this case.

And if you look at the little yellow, you can see a train with the little yellow triangles. Those are apparently, look like high tension lines, utilities, power utilities.

And in this case, so we're showing here the flooding potential here with no storm and no sea level.

And then you can easily flip through, you can see this is with a 25 centimeters, with 50 centimeters and so on, and you can flip through, and this is all without the storms.

And what sea level rise would you choose? Well, you already know by the State mandates, and so forth. But there is a little tool if you want to see what some of the research has shown, that you can pull the bars on the tool and you can see what some of these -- how they fall within the year.

So, on the top panel, you can actually scroll, look at the years and see where the bars fall from the different studies. And down here you can do the reverse, and pick a sea level rise and see what years those studies have projected those for, as a comparison.

An important aspect is always uncertainty. There's always uncertainty in modeling and in future, guessing out to future conditions and climate change. So, we provide a layer, a flood potential layer we call it, and this is basically an uncertainty bound, lower and upper uncertainty bound.

And within that bound we do our best to account for vertical land movement, so we have spatially varying vertical land movement, marsh accretion, the elevation uncertainty and the digital elevation model, itself. And also model uncertainty, which we get both from the grid resolution, as well as mathematical approximations that are built in to the model.

So a thing that you can also do, obviously

there's a lot you can do with this tool, you can look at -- you can compare the storm scenario with no storm scenario. So, on the left-hand side, and I'll flip through a couple of them, is just the sea level rise scenario. And on the right-hand side is the same sea level rise scenario, but with a 100-year storm on top of it.

And you can see, on the right-hand side, it's typically quite a bit larger. So, we're finding that it is important, as one would expect, to include those storms. It's not just the sea level rise. This is to point out the point of the bathtub is a good first approximation, but we can go a little further than that.

And finally, there's a nice little thing you can do, there's an icon you can click on and you can draw a little polygon wherever you would like, at your area of interest, and then wait a couple minutes then you get this report that summarizes the extent of flooding, the percent of area that flooded, and the depth of flooding with all the scenarios and with the storms. So, it combines them all.

And that -- for more information, here's the contact information, and so forth.

MS. ZAFAR: Thank you so much.

MS. ERIKSON: Okay, thank you.

(Applause)

MS. ZAFAR: So, I will now turn it over to the dais, if you guys have any questions. And then, I have a few -- oh, I'm sorry, I just remembered something.

The CEC would like for you to fill out this card if you have public comment. Public comment is from 4:00 to 4:30. So, please fill this out. She is over there, and give it to her.

CPUC COMMISSIONER RANDOLPH: Okay.

MS. ZAFAR: Commissioner Randolph.

CPUC COMMISSIONER RANDOLPH: All right, does anybody have any questions?

MR. ALEX: I have a question, primarily for Guido, but anybody else, as well.

Since we have a panel from the utilities next, if you can identify the most important data and information that you'd like to get from the utilities, that you're not currently getting, we'd be interested in hearing that.

MR. FRANCO: Yeah, I think what is important is to work more closely together. But also, I think we have to make the utilities comfortable sharing confidential information. They don't need to share it with the Energy Commission or the CPUC, but I think they need to share it with the researchers. And the

researchers don't -- they don't need to disclose that information.

I mean, a perfect example is the data used by Professor Max Auffhammer, you know, where he had house, confidential household level data, and he was able to do the analysis and present the results to us.

Another example is the natural gas pipelines in the Delta. I mean, we knew that there were some errors, so the researchers were able to talk, to work together with the utilities, in this case PG&E, to make sure that they were using the correct information.

Now, the GIS confidential data, with hydro solution -- well, the accurate GIS data, we don't need to see it. I mean, the Energy Commission, we don't need to see it, we just need to see the results of the study.

Yeah, one thing I would like to say, since I have this opportunity, so the EPIC Program has funding to support projects for the electricity sector. The natural gas program can only fund projects for the natural gas program.

We don't have such a funding for the petroleum sector. So, refineries, oil pipelines, I mean nobody's studied it. Actually, we're going to start doing that, there is a one-time availability of funds for the Energy Commission, so we're going to be using that to start

exploring this issue. But the long-term problem is there is not a steady source of funding to study the vulnerability of the petroleum sector and to also look at potential adaptation options.

MS. ZAFAR: Regarding the information, the energy information from the utilities, Ken and I worked on an energy data center a while back. Although the Commission didn't go that far, to the energy data center, but last year we did pass a decision that would streamline the process for researchers to get data from the utilities.

So, if that's not working or if it's -- if you need more information, give me a call or send me a note.

Others?

CEC CHAIR WEISENMILLER: Yeah, I had a couple. One is I wanted to make sure that the researchers who mentioned, basically, websites, that we make the -- Scott's is upcoming. But, anyway, when that's available, we make available to everyone, who is here, the appropriate links so they can tie in.

The other question I wanted to ask was about trying to look at disadvantaged communities as we go through this analysis. You know, essentially, certainly we have identified disadvantaged communities, so it's a question of trying to look at impacts of climate change

on those of our citizens.

MS. ZAFAR: So, who was the question directed to?

CEC CHAIR WEISENMILLER: Well, I'm looking at Guido so, yeah.

MR. FRANCO: Yeah, so, I mean that's a mandate for us, so we are -- like for example, we're looking at how climate change will disproportionally impact disadvantaged communities.

For the sea level rise issue, it was the same thing. When we looked at the areas affected, we also look at the areas where we have disadvantaged population and how they will be affected by sea level rise.

But in general, yes, as a mandate we will follow through to make sure that we address the issue of how to identify disproportional impacts and also how to provide, suggestions on how to overcome those impacts.

MR. FLINT: And I can just add, from the perspective if the Desert Renewable Energy Conservation Plan, our draft was also a draft EIR/EIS. So, we did an analysis and identified the environmental justice and disadvantaged communities in the desert, of which there are quite a few.

And in the second part of this, the second phase of the DRECP, we're planning to use the Climate Console

and Data Basin to make the data from the DRECP available to the counties doing their general planning. So, they certainly have the same information, basic information on -- and basic climate datasets that they can use to examine the human environment, too, not just from a biological and conservation perspective.

CEC CHAIR WEISENMILLER: How about Cal-Adapt?

DR. WILHELM: Cal-Adapt will be displaying many of the results from the Fourth Climate Change Assessment, including the socioeconomic and land use scenarios that are being developed to support the assessment.

And we're also working with Cal-Enviro Screen, as well as Cal-EPA, who has recently completed an urban heat island study to see how those datasets might be able to work with Cal-Adapt.

CEC CHAIR WEISENMILLER: Okay.

MR. FRANCO: But also, the Cal-Enviro Screen, so it will be, I think, somehow displayed in Cal-Adapt, too. I mean, there will be some connection between the Cal-Adapt and the Cal-Enviro Screen.

CEC CHAIR WEISENMILLER: I was just going to follow up on your comment on data. I think it's important that data be accessible to the researchers. But I think that the results, particularly identifying

key vulnerabilities, should certainly be available to the PUC and to the Energy Commission, so we can target where we want to focus our mitigation activities.

CEC COMMISSIONER DOUGLAS: So, I've probably got one, broad, open-ended question and one really specific one. I'll start with the specific one.

The CoSMoS Model, you know, I've heard a bit about it and been briefed on it to some degree, and it seems like it will be very, very, very helpful.

What is the time frame for that to be available statewide or up and down the coast?

DR. ERIKSON: So, by this time next year the rest of -- the Southern California bite should be available. And the Pt. Arena extension, as well, up to Pt. Arena.

CEC COMMISSIONER DOUGLAS: Okay.

DR. ERIKSON: But then there is a missing portion in Central California and to the north of Pt. Arena. And that, I would say another couple of years, probably.

CEC COMMISSIONER DOUGLAS: Okay. All right, thanks. Well, it certainly looks like a really exciting and useful tool for that issue.

You know, my broader question or I'll start with an observation is that, you know, here we are in a

workshop on climate adaptation, focused on the electricity sector, and we are hearing something that, you know, we could be hearing in the same way if this were focused on the water sector, or species conservation, or agricultural, or public health. You know, we're hearing about climate change and how it's interacting with our environment and infrastructure, and it's stressing our environment and infrastructure. And it's challenging, in this case, our utilities, our service providers to deal with changing conditions and adapt in new ways. And it's challenging our agencies, you know, in this case Energy Commission and CPUC.

But in other cases, of course, you've got other daises and other agencies, with their own perspective on issues.

And, of course, this is all happening at the same time and these issues are all interrelated. So, in the real world, and Scott's presentation kind of gets at this, you have to be able to think about electricity system adaptation and, by the way, how does that mesh with and how do we handle that in a context in which the natural environment's changing and that greatly affects our species conservation world. And how does water play into this, and public health, and socioeconomic?

And so, what we see, as we look at the big

picture on climate adaptation, is this incredible complexity and interrelatedness.

And I think it was the speaker from SMUD, whose words kind of stuck with me a bit, from this morning. You know, organizational culture is what happens when no one tells you what to do. And most of the time, people tell you what to do all the time, but they don't always tell you, you know, how to work together and how to solve these cross-sectoral issues. And even if you want to, you find that most of our institutions are not really hard-wired at this point to do that.

So, I guess the question coming out of that observation, and maybe I'll pick on Louise, because with the Governor's Office and OPR role, you probably run into this every day. But I'd be really interested in your observations on how we address, you know, and maybe I'll borrow Tim Sullivan's words from this morning, too, how we address the social issue of adaptation, as opposed to the technical issue. Because we're really good at technical solutions.

But I think, you know, these meetings can sometimes, by the end of it, feel a bit frustrating, too, because in a way what we have to solve is a social problem, I think.

But I'd love your thoughts. And I didn't mean

to just pick on you, anyone's thoughts on that.

MS. BEDSWORTH: No, I think that observation is right on. I mean, I think that's the challenge. But I also think, I mean what I was going to point to is what we see in the regional approaches where I think, I mean much of what's going to happen -- the State, obviously, has a very important role to play on adaptation, but the effects are very local, and they're going to vary. They're going to vary across region. And how they interact with one another is going to vary across region.

So, I think that that word, "regional", being in the Executive Order is really important because it is a shift from our sectors, which work very well for us at the State. But I think when you're working on the local level, you need to be able to work in a place-based way.

And so, I think our challenge is really to think about how we link those two things. I think ARCA and the Regional Collaboratives is a really interesting opportunity to do that.

I think the work we're doing through the National Disaster Resilience Competition is another, where it's really we're looking at, okay, we have federal partners, we have all of these people with similar ideas of what has to happen, but how do we link

our community resilience with our statewide goals, with the federal goals? You know, and so I think the DRECP is another great example.

And I think it's those -- it's how we build -- I don't know that I have the right answer, because we're doing a lot in -- we are doing it in places, but being able to make that transition between these place-based efforts and these broader goals is going to be the key.

And I think for us, at the state level, it makes a lot of sense to take a sectoral approach. But we're going to have to think about how we make that translation down to a place-based approach, as well.

CEC COMMISSIONER DOUGLAS: I think that makes a lot of sense and it's a good observation. You know, I'd love to follow up with you on that a bit offline. We've certainly been working with some local governments in the desert, but not only in the desert. And it's been pretty interesting to see how different a lens you can bring to issues when you're really rooted in a specific place. And any issue at all that comes out of that place can walk through your door at any minute.

MS. BEDSWORTH: Right. And I think we have some neat opportunities that we're maybe not taking advantage of right now, that we could.

And just another example that I think, you know,

has energy implications to it, but much broader, is the fire that occurred in Weed, California, last fall. The Boles Fire that destroyed over 180 houses, critical infrastructure, all of these pieces.

They're getting a bunch of money -- not a bunch. They're getting some money through the Community Development Block Grant Program that's administered by HCD. They have said, we want to think about how to incorporate resilience in this.

And so, I think we're also getting pushed from the local level to think about, okay, you know, how do we help them with this federal money, that is administered by the State, to do that.

You know, so I think we have a lot of opportunities that we will start taking advantage of more, both because we need to, but also we're starting to hear that from local communities, too.

So, yeah, I would love to talk to you more about it because I think there are a lot of opportunities.

CEC COMMISSIONER DOUGLAS: Great, thanks.

MS. ZAFAR: Before going to the next panel, Commissioner Randolph, did you have a last question?

CPUC COMMISSIONER RANDOLPH: Oh, I just -- more of an observation, than a question. I liked the way you guys put together these panels because they're talking

about the information we need and the ideas out there, and then seguing into having the utilities come up and then kind of tell us what they're up to is perfect. Because, you know, I think we need to start thinking about ways to make sure it's not just the public agencies that are talking, but the agencies and the utilities.

And I loved the DOE's model and am very interested in following up on how we can do something liked that at the State level, in conjunction with the CEC. So, very interested to hear from the utilities.

MS. ZAFAR: Thank you, panelists. And on that note, we're going to start with the utilities panel next. Thank you.

(Applause)

MS. RALFF-DOUGLAS: And now, for our final panel of the day we have four utilities represented. Each of them are going to give a 15-minute presentation, talking about what they are doing in terms of adaptation, generally, and then specific examples of things that they are dealing with.

A lot of what you heard this morning is that there's long-term adaptation issues, but then there's a lot of things that we are trying to adapt to now. And a lot of what the focus of the utilities is kinds of

aligns with emergency management or emergency crisis, on some levels.

So, I'm going to hand it over to Diana Day, as the first speaker for this morning -- or this afternoon.

MS. DAY: Thank you. My name is Diana Day. I've the Vice President for Enterprise Risk Management and Compliance for Southern California Gas Company and San Diego Gas & Electric Company.

I'll be sharing the podium today with Jimmie Cho, who is our Senior Vice President for Gas Operations and System Integrity, also for both San Diego Gas & Electric and for the Southern California Gas Company.

So, I'm going to start. Jimmie's going to come up and then I'm going to wrap it up for us this afternoon.

We will be addressing two themes today. How San Diego Gas & Electric and SoCalGas look at climate adaptation from a risk perspective.

And secondly, ways in which in which we are partnering on climate adaptation matters.

We understand and have had a dialogue with Kristin about the difference between climate change, climate mitigation, and climate adaptation. And, internally, we use the following definition for climate adaptation, which is consistent with the 2014 national

climate assessment definition.

The definition that we use for climate adaptation is a capability to anticipate, prepare for, react to and recover from significant, multi-hazard threats with minimum damage to social wellbeing, the economy and the environment. I know that's a very lengthy term, but it's comprehensive. And that's how we define and react to adaptation at our companies.

At SoCalGas and at SDG&E, we are in the process of formalizing our enterprise risk management processes, quantifying risks and developing a more consistent, transparent and repeatable processes for evaluating risks.

And that includes the risk of climate change. We're in the process of scoring climate change as a separate risk. But one thing that has struck us, as we've embarked on that effort, is that many of the top risks that we've already identified have a very strong correlation with climate related issues.

On the electric side, one of our top risks is the risk of wildfires and that's clearly correlated with drought and extreme temperature situations.

Issues around our electric infrastructure integrity are linked to sea level rise and flooding issues.

And for our gas systems, we see links between the risk of having an adequate natural gas supply that's linked to extreme temperature changes. And issues around storage well integrity are linked to flooding and landslide risks. And we'll be talking about those later in the presentation today.

As we go through the presentation, we're going to discuss how we're leveraging the latest science and technology to anticipate and quantify risks associated with the changing climate, and also how we collaborate with our community and educate internally to make better risk-informed decisions.

We'll also be giving some examples of adaptation efforts that we believe are making us more resilient to these inevitable changes.

At SoCal, we will highlight efforts related to landslides, flash floods and subsidence.

And at SDG&E, we're going to talk about some of the adaptation considerations that we had in connection with the South Bay Substation.

Again, the goal of our efforts around this is to minimize the risks associated with social wellbeing, the economy and the environment.

An important part of our risk efforts is to ensure that we have adequate data to measure risks. I

really liked Dr. Grove's presentation this morning, where he talked about the need for data-driven strategies. That's an important part of our risk approach.

We are currently looking at data that describes the risk of sea level rise in our service territory. On the lower left here, you'll see some information that was recently published by the San Diego Foundation, and we used as part of the Port of San Diego Adaptation Plan.

This data indicates between 12 to 18 inches of sea level rise in San Diego by 2050. And there are pending reports that are expected to exceed these values, although those papers and studies have not, yet, formally been published.

The recent San Diego Foundation report predicts the following consequences in our service territory. Beaches will shrink and some will disappear completely. Fragile sea level cliffs will collapse. Coastal properties will be flooded with increasing regularity. We can expect to see more frequent high waves and rough surf that brings the potential for significant damage, especially during storms. And we can expect to see coastal wetland will lose their capacity to filter polluted runoff and keep beaches clean.

In the upper right, this is an interesting image. Dr. Fischer Wilhelm just talked about the requirement for a 1-in-500 year, looking at sea level rise from that perspective. That's what this image shows. And for those of you familiar with Sea World, this is in the area of San Diego around Sea World.

This is taken from a U.S. Geological Survey project that shows the potential for coastal flooding in San Diego Bay today, if we were hit by a 1-in-500 year winter storm. The results of that survey indicate that areas of our coastline could be very heavily impacted, including areas such as Coronado and around Sea World.

When this sea level rise is coupled with stronger storm systems hitting our coast during the winter months, we see the potential for coastal damage increasing into the future.

And, of course, as a utility we care not only about that in terms of the impact to our community, but we have customers and infrastructure located in those areas and we are looking at it from that perspective.

We've also identified an associated aspect of climate change risk as it relates to large climate swings. The increasing temperatures are already showing to have an impact across the regions of our service territory.

We are already seeing an impact from extreme heat waves, like the one that was experienced last September 16th, when we set a new electric system load at SDG&E, 4,890 megawatts. As we heard this morning, we anticipate this increase in temperature will increase into the future.

As Dr. Cayan mentioned this morning, consistent with his observations, our internal investigations are also showing that there's a significant impact from the warm, overnight low temperatures that are projected to accompany our heat waves in the future, as well.

And if you look at the purple chart on the upper left there, notice not just the blue trend line, but that the bottom temperatures are increasing. This has an impact on our electric system.

I'm told that this was experienced earlier this month in New York City, when an extreme heat wave was accompanied by overnight low temperatures which remained in the 90s. And that resulted in record loads.

We're also seeing the heat building up this summer over the Pacific Ocean. With El Nino already approaching a strong status, we are preparing for the pendulum to swing and potentially see a return to storm conditions, once again, across Southern California, a trend that we are beginning to prepare for.

Our meteorological experts at SDG&E are telling us that the current El Nino is trending close to the El Nino's of 1982 and 1997, where we have seen historically significant rainfall and winter storm activity.

Just the weekend before last, the remnants of Hurricane Delores moves into the Southern California region, bringing flooding rainfall to our region. It was very odd, I can tell you, to have an electrical storm in July, in San Diego.

And our meteorologists, in analyzing that storm, have determined that that was a 1-in-200 year event.

Returning to the chart, on the upper left, this graph was generated by the National Oceanic and Atmospheric Administration and shows the rapid temperature increase.

On the upper right, this image was generated for the San Diego Foundation's most recent climate report for San Diego. The research was provided by the Scripps Institute of Oceanography. And it shows that since 1985, temperatures have increased 1.7 degrees. And projections are that by 2050 temperatures will be 4.8 degrees above the 1985 baseline.

In the lower left, this image was generated by our meteorological team. And it shows water temperature anomalies across the Pacific, as of the middle of July.

El Nino is rapidly approaching strong status and showing indications of strengthening as we approach the fall.

Analyzing risk starts with good data and we are taking steps to collect meteorological data so that we can adapt to climate change in our service territories.

At San Diego Gas & Electric, I'm proud to say that we have developed the largest and most sophisticated utility weather sensor network in the country to monitor adverse conditions at all times.

We have 170 weather stations and they're shown on this graph here.

As part of our original wildfire adaptation plan, SDG&E realized that we needed to make adjustments to the way we would operate our electric system, taking a circuit-by-circuit approach through our back country.

To that end, every circuit that we operate in our high risk fire areas has at least one weather station, supporting our adaptation to the increase in wildfire activity, and helping us identify and quantify other climate-related risks to our electric system.

We have archived every weather observation that we have ever received, developing a comprehensive climate database to support adaptation efforts as we move into the future.

On this graph, which shows our weather stations,

we also show within the red lines, that is the SDG&E fire threat zone, which is a fixed zone. And then the shaded area that's in the middle there, that's what we call our back country, the eastern portion of the San Diego Gas & Electric service territory. That is our 2015 high risk fire area. And the highest risk fire area is re-determined every year, based on data that we have and predictions about weather conditions.

The picture in the upper right shows two of our SCADA technicians installing one of our weather stations. The weather stations are 20 feet above ground and they measure temperature, humidity, winds, and some also measure rain, solar radiation and pressure.

Those weather stations provide us with reads every ten minutes, or about 1,120 data points every hour of every day.

The weather station also has 35 cameras, which we own and operate, and we collaborate with the University of California in San Diego to support a network of another 110 cameras across 20 mountaintops. So, that's 145 cameras.

I will note that one of my colleagues was watching the news last night about the fire that's going on in Nevada, and the weather person made a comment about Nevada having six cameras. We have 145 in our

service territory.

This graph shows how we are using the data collected from our weather stations and it relates it to drought and wildfire risk. Drought creates additional issues across Southern California, in addition to the water resource issues that we heard of this morning, and that some of the other utility panelists will be discussing.

Some of the largest wildfires in our State's history are fed by drought-stressed vegetation.

Being a leader in wildfire adaptation, SDG&E has partnered with the United States Forest Service and UCLA to leverage big data analytics to better understand wildfire trends across the region.

Understanding that risk, we are able to implement our comprehensive climate adaptation plan, which has been built around the increasing wildfire threat across Southern California.

In addition to showing the overall increase in days that we experience high wildfire potential, the data also suggests that we are seeing a longer wildfire season.

Last year is a good example of this. May 14th, 2014 was rated as having the fourth highest wildfire potential in San Diego for the last 30 years.

I will note that those wildfires were not only in the highest threat index in the inland, but were also along the coast. So, we're seeing an increase not only in the time of year in which we're seeing wildfires, but the geographic area as well.

The graph shown on this slide uses data that was generated on an SDG&E super computer, with cooperation from the U.S. Forest Service and UCLA. It depicts custom fire potential algorithms which were developed to rate the fire potential for every day going back to 1984. So, it's a back-casted algorithm.

The graph shows 30 years of daily fire potential, with large fires indicated by the circles. So, what the algorithm predicts is the length of the lat bar. And you'll notice that on many of those highest bars, we actually had wildfires.

We've also seen a significant increase of high risk days over the last 15 years, a trend that is forecasted to continue.

Not only are we looking, taking our data to look backwards, we're also using it in a predictive mode to make risk-informed predictive modeling around the wildfire threat.

We have co-developed a nationally recognized tool with UCLA and the U.S. Forest Service. It's called

the Santa Ana Wildfire Threat Index. Additional partners on this project include the National Weather Service, CAL FIRE, UCSD, and the Desert Research Institute.

The Santa Ana Wild Threat Index is basically like a hurricane scale for Santa Ana ratings. It rates the potential for wildfires on a scale from no rating to extreme. So, similar when you hear a hurricane and it's Cat 1 through Cat 5, this is similar for the threat of Santa Ana's.

It will help us anticipate extreme events as they approach our region in the future. We have increasing confidence in this information and algorithm due to its proven ability to identify historical high-risk wildfire days, as shown on the previous side. And this algorithm allows us to look forward, which allows us to better prepare and respond by initiating our Community Fire Safety Plan, which is part of our Wildfire Adaptation Plan.

Being able to anticipate these events enables enhancement preparedness through developing and executing an appropriate adaptation plan to reduce risk.

This science is all being integrated back to the fire agencies and the general public. With 20 million Southern California residents having access to this

information through the U.S. Forest Service.

We hope this project will serve as a model for the development of additional tools supporting climate adaptation plans in the future.

This slide shows some of the efforts we are taking internally to expand the understanding across our organization and within the community around climate change adaptation.

In an effort to adapt to sea level rise, SDG&E and SoCalGas are applying for a CEC grant, which is focused on adaptation efforts. If this opportunity comes to fruition, we would embark on a well-coordinated, multi-year project beginning later this year.

We're also collaborating with the Scripps Institution of Oceanography and plan to continue that collaboration into the future.

As part of the work we're doing with DOE, which was discussed this morning, we're developing an Internal Climate Vulnerability Report, which will compile the most credible and recent scientific information available to help determine potential threats to our system.

We also have an internal, Cross-Functional Climate Advisory Group within our organization, which

brings together the expertise of 15 different departments across our company to identify where infrastructure is susceptible to climate risk and how we can better develop adaptation plans to minimize those risks in the future.

And, finally, I would be remiss, I ran out of slides and time, but I would be remiss in not mentioning the Borrego Springs micro grid, which Guido Franco mentioned a few minutes ago. We're really proud of that. That's an example of the adaptation that we're doing to the extreme weather conditions in our service territory.

And now, I'm going to turn it over to Jimmie to talk about adaptation at the SoCalGas system.

MR. CHO: Diana, thank you. And I want to thank the leaders from the State office, the Commission, CEC, the Governor's Office.

One word that Craig used earlier was interdependency and the holistic approach. And there's so many things going on, unless we really work together we really won't have an effect, we won't be -- it just won't happen. So, bringing this together, I appreciate that.

By the way, I want to let you know, we manage both utilities. So, on the gas side we manage it as an

integrated gas transmission system. We've got about, just under 4,000 miles of high pressure transmission line. And we go from the Mexican border, the Colorado River up to the Fresno County line and the Hearst Castle.

It's a lot of stress. I'm actually 27. And I used to have flowing locks of hair, recently, but --

(Laughter)

MR. CHO: I want to just share a story with you as a starting point, and then give you some examples. I was fortunate to talk to a group of customers, major customers in San Diego, not too long ago. And I asked the question, you know, when do you think gas is most in demand? And they said, without a beat, boy, when it's really cold I use gas, I heat up my house.

And I said, that's true. But I said, one of the highest days and, more importantly, one of the highest times we had gas send out was during the summer, late summer. And it was on a September day, and it happened to be not midday, but early evening. That is the reality of what is happening today.

And why did that happen? It happened because of the energy portfolio and the diversity of our portfolio, right. Is a peak EG demand day electric generation? And guess what happens after a certain time, the sun

goes down, the wind stops blowing. And underneath, underneath our electric reliability, we can't forget, is the fuel that runs it. It's natural gas. The peaker plants, the base plants rely on clean natural gas to provide that reliability. So, that is a reality that a lot of our constituents don't really grasp until I share that.

And I think the other thing I learned today, just sitting here, is three things. One is not only about climate change and trends, but climate extremes. That's really important.

And the third thing is portfolio diversity of energy. We talk about energy in terms of, you know, months, seasons, years, but I want to just bring back to you, I talk about it in terms of hours. That's how I live every day, it's an hourly issue.

Now, let me go through some real important examples of what we're doing in terms of adaptation. For us, in the gas system, things are buried underground, so folks don't really take notice of it. But the earth moves, right.

So, one of the things that we focus on is stresses on our pipeline system. And we look at land movement, landslides. In fact, after the Northridge earthquake, we had a lot of land movement in our Aliso

Canyon storage field. So, the remediation for that was a lot of geotechnical work, and we do that. And that will be invested benefits, not just for the earthquake event, but for climate change in the future, as well.

Then the other thing that we're very mindful of, if I can go back one. Well, on this one, what we're mindful of is extreme weathers, right. We think about heat, hot temperatures. But last weekend, I believe it was, two weekends ago, actually, there was a major flash flood in the desert. And all of you know that on Interstate 10, a bridge washed out. Well, just north of it, guess what, there's pipeline infrastructure.

So, here's an example of not of hot weather, but of a flood situation, of an instant in time when an El Nino type incident could have damaged the piping. It was fine. Our system is very resilient. But I wanted to just share that incident with you, that is a reality.

The other thing that we're doing to adapt and to manage risk is technology, obviously. And we're looking at satellite technology. The Pipeline Research Council, or National PRCI, is one of the organizations we're involved with.

And we want to use what's out there in terms of remote sensing, so that if there are changes, subsidence, movement, encroachment we can see that

change over time.

And then, I want to share an example of how, today, we are using awareness and proactive behaviors when it comes to climate change, and talk about our South Bay Substation. This is SDG&E. And this is a substation that was constructed over half a century ago, and it doesn't meet today's needs. So, we're constructing a new one.

And in doing that, we're looking at sea level rise as a potential threat. So, we are grading and elevating the substation accordingly.

And then even more immediate, to the extent that we can for soils compaction and for dust control, we're using recycled, reclaimed water. So, we want to make this part of the fabric of our planning and construction, as well.

And then, for us, in terms of the partnership, it's not just with agencies, other utilities, but first and foremost our communities and our customers are the biggest stakeholders. So, we have a very robust outreach program at both utilities, helping businesses and customers understand how they can help be part of the solution.

And then the other thing that was mentioned quite a bit today is the work DOE is going with some of

the private investor utilities. And I think the biggest challenge for us isn't the discussion, it's the execution, it's the action that we need to take around the issues that we know, and then bringing interdependencies together to have common solutions, that are cost effective, and that are risk-based.

And I'm going to actually turn it over to Diana. I lost my water somewhere, so if you find a bottle of water, please let me know. Thank you.

MS. DAY: We were asked, as part of preparing for this, to talk about suggestions and opportunities that we see, recommendations that the utilities have.

And this slide, there's really three themes. We do see the need for research. I know that was discussed this morning. But we think it's critically important for the utilities to work collaboratively with State agencies and federal agencies to make sure we're on the same page.

There have been examples in other states, where utilities have begun research, they weren't on the same page with some of the agencies, they had to start from scratch, again. And that's not a good way to proceed. So, we really would like to work collaboratively, make sure we're proceeding on the basis of an agreement for those studies.

The second through fourth bullet points are suggestions that came out of the 17 utilities that met with DOE. We support all three of those recommendations.

And the last recommendation is what Jimmie alluded to. We do use recycled water in our construction activities. But because of some State and local regulations and restrictions, that's not as easy to do as we would like.

We're aware of examples in our service territories where reclaimed water is being dumped into the ocean, millions of gallons a day, because it can't be shared across local jurisdictions.

We would very much like to use that water and work with the appropriate agencies to make it easier to use recycled water in our construction activities. And we think there's opportunities within the State to advance those regulations.

Thank you.

(Applause)

MR. GRIGAUX: Okay, good afternoon everybody, and thank you again for the invitation to participate on behalf of Southern California Edison, in this workshop.

Just briefly, what we're going to cover here, this afternoon, is a brief overview of the types of

climate impacts that we, in Southern California Edison, confront today and in the foreseeable future, and how diverse those are.

We'll then touch, real briefly, on the framework that we in fact use today, already, to deal with these climate impacts in our planning and operational protocols, and processes to mitigate those impacts, which we believe effectively could be used as a model, so to speak, for really incorporating more of the longer-term perspectives that are not really fully embedded in our planning processes today, but that we're working towards doing going forward.

Then, we'll do a deeper dive on the wildfire risk for our company and how we go about mitigating those and with today's tools. And touch on, briefly, some next steps.

So first off, just as a brief overview, for those of you not familiar with Southern California Edison, we have -- we operate, in fact, between SDG&E and PG&E, sort of Central and Southern California. Cover a service territory of about 50,000 square miles. Service 5 million customers, 14 million population. Have about 115,000 circuit miles of transmission distribution. And about 5,000 or 5,500 feeders or circuits that we rely on.

We operate effectively in a quite diverse climate zones today. We serve the coastal regions, we serve desert communities, we serve mountain communities. So effectively we, today, confront pretty extreme events and, therefore, design, construct, operate, engineer with these in mind. And those are effectively incorporated in how we build our system and operate the system. So, we deal with high heat conditions, low temperatures, wet, dry conditions, fires, rain, lightning storms, snow and so on.

So, it is very much, today, part of how we actually design and build a system and mitigate against these impacts.

That being said, and also considering that effectively we use, today, a design criteria of a 1-in-10 heat storm as part of building the system, and operating the system, we do not incorporate sort of long-term horizon projections of what these climate impacts, that we've been discussing today, into our planning process. And it is something that we are working towards, as was referenced this morning. There were a number of references to Southern California Edison joining a number of studies out there, between DOE and the CEC.

We've recently, also, just joined the Lawrence

Berkeley National Lab's funding, an effort there to look at climate adaptation, as well as looking at the impact of wildfires on our transmission distribution system. So, we look forward to continuing down that venue and sort of build some scientific-based data to help reinforce our planning process.

So, this is a framework that effectively mimics how we operate and how we plan today, and incorporating a variety of trends and forecasts with respect to load and generation capacity throughout the service territory.

But as it relates to climate change, we would effectively like to use scientific-based, consensus-drive criteria and data points, and analytics and tools that we've been sort of referencing today to really incorporate in our planning process going forward. To make sure that we can, in fact, develop some specific -- a better understanding of the vulnerabilities onto our system by overlaying those trends on our grid, and understanding how they would impact, and how resilient our grid is today, and where the gaps are. And then, work towards a balanced set of solutions that would really address the safety risk to the public, as well as the reliability of our system with the costs to serve -- to serve those needs, and those changing needs over

time.

So, jumping into, now, the wildfire risk, which is specifically the type of severe event we've been asked to touch on here.

So, I'll do a deeper dive on this. Effectively, what we'll do here is I'll touch on the data that we rely on today, and how we better understand, if you will, the types of risks that we're confronting across the service territory.

Talk about how we identify those vulnerabilities and then talk about the actions that we take to mitigate those.

Sort of a busy slide here but, essentially, it's meant to capture the basis of the data that we use today. So, we do rely on the CAL Fire, that was referred to here as, FRAP fire threat maps, as the basis for understanding what types of fire risks we are facing across the service territory.

So, it looks at sort of the density of the fuel. It looks at potential ignition sources. And looks, also, at the wildland urban interface, which is really the areas where we have the most vulnerabilities in our system.

We overlay that on top of our -- the distribution, our distribution and transmission, and

substation grid. In addition to overlaying our high wind data sources that we have for the service territory.

And understand, also, the distribution of the 1.5 million trees that we manage proactively today, and through our veg management program.

And, effectively, come up with a definition of our high fire areas throughout the service territory.

A subsection of those high fire areas, the definition of which we've developed, we focus on 113 of those, specifically, which is a small section of the high fire areas in our service territory, to take additional actions in preempting and mitigating the risk of fires there.

The challenge with this data, to be transparent here, and to be clear, is it is dated information. These fire maps are about ten years old. They don't get refreshed on a very dynamic basis. And knowing what we're confronting here, going forward, and how the changes are expected to accelerate over time, this is something that we'll need to address going forward, to make sure we have access to some more dynamic data across the industry.

So, then, what we do with this data is we reinforce the compilation of this data with some actual

field inspections and patrols that we conduct in the field. So, we have approximately a thousand, about 5,500 circuits that fit within these high fire areas. We conduct specific patrols by our troublemen and patrolmen, ahead of the fire season.

We also reinforce that with both annual, and semi-annual, and even quarterly inspections by our veg management group to ensure that we are meeting the minimum clearance requires. And, actually, going above and beyond that, going down to not just primaries, but also inspecting, and patrolling, and correcting overgrowth in our secondary part of the system, especially in those high fire areas.

And then, finally, we remove -- we have a proactive program, we just launched this year, of removing dead trees, dead shrubs. Not just within our right of way, but also outside of the right of way that could impact these lines and potentially trigger or be an ignition source for a wildfire.

And then, finally, we also have implemented, approximately 15 years ago, what we call Operation Santa Ana, where we partner with the City, State and County fire departments throughout our service territory to proactively patrol these very same corridors. And we partner up in some pairs, and we do that, really,

throughout the summer months. We started about a couple months ago and we'll continue for the next couple months.

So, those are very -- we take -- effectively, are pursuing very proactive patrols and inspections in the field, in addition to the data that we have, to really better understand what vulnerabilities we have and be better prepared to mitigate the impacts of wildfires.

So, in addition to these patrols and these inspections, we've -- and those, by the way, are captured in a Fire Prevention Plan which we submitted to the CPUC in late 2012, amongst a number of other activities that we performed, as well. I think I hinted, earlier, that we incorporate these very criteria and these very conditions, extreme conditions in our design and engineering standards today, but as well in our construction, and maintenance, and inspection standards and protocols that we have within the company.

We also implement, in addition to these activities, some specific operational practices and protocols in the company. And these include having a fire management, a fully engaged, full time staff working closely with the various city, county and state fire agencies to both monitor, and also respond, and

become a full time liaison with those agencies to ensure that we're well-coordinated in pre-staging crews, both our crews and the 10,000 plus firefighters that we have available to make sure that we preempt any of these fires in our service territory.

We've also trained our troublemen and our senior patrolmen, and a variety of other qualified personnel in the company to be fire watchers. And effectively, again, identify ahead of time the potential for these fires.

And then, finally, we've implemented, many years ago, this system operating both in 322, it's an internal bulletin that we use that effectively puts in place some operating restrictions in certain conditions. So, we have the Santa Ana season in Southern California, that some of you are probably very familiar with. At which point we operate or we trigger these operating restrictions.

And we also have red flag warnings that are declared by the National Weather Service or the Riverside Fire Weather Office, occasionally. And when those are declared or when we reach those periods of the year, we effectively turn off the automatic reclose of our automated recloses or switches that we have in the field.

So in other words, when there's a fault that's detected in the field during these operating restrictions, we don't test a line until we fully patrol the entire line, ensure that we don't contribute to or make something that is already a bad situation even worse.

So, that's proven to be quite effective for us. All of these really are about proactively, you know, staging crews, taking operational measures to preempt any of these wildfires from occurring in the first place or detecting them very early.

Something that we've just started pursuing is something very similar, in different ways, to what SDG&E implemented a few years ago, which is the flame sniffer technology.

And this is effectively a weather station that we strategically locate on our transmission towers. This is a pilot that we've just started, it's relatively new. It not only does what a typical weather station does do, but it also can detect flames, smoke, elevated levels of CO2, and ignition sources. And it provides real-time video of what those may be and it sends an alarm, if you will, real-time, to the local fire department, local fire agency, as well as the utility. Enabling us to really, again, proactively respond to the

extent we don't have crews staged there in the area, and take appropriate measures.

And then, finally, we also have adopted, many years ago, as part of our Bark Beetle project, the ability to empower qualified field personnel to temporarily isolate or de-energize a line or a line segment if field conditions warrant taking such drastic action.

This is a busy slide, again. But, effectively, really summarizes the various standards, protocols, and practices that we've adopted in the company that are, again, designed to deal with these fire threats today.

We have taken on some new measures, in 2014, when the Governor declared a state of emergency. Which essentially increased or expedited a number of the measures we already have in place, in addition to taking proactive steps in ensuring our protective devices have the proper setting, or installing additional protective devices in the field where we may have had some vulnerabilities that were not previously identified. So, that essentially captures that.

And then, finally, just in summary, and most of the prior speakers already captured many of these points, we obviously are concerned about the same kind of climate impact projections that we're witnessing

across the nation and across the world. And how that may impact our customers, the safety of the public, the reliability of our system in the long run.

We do have a resilient system today, that has been built, that really considers some extreme events. But we do not have, in our planning projects, in our planning processes incorporated the long-term impacts and projections of these weather events.

So, as I think as has been pointed out earlier, where we do believe that we need some increased collaboration and coordination amongst the different stakeholders, specifically in the State of California, working with the various agencies to really consider a single source of truth, so to speak, looking at scientific, scientifically-based and consensus-driven data that will be supported by the Commission, and the various stakeholders. So that we can, in fact, have some higher level of confidence and reliability. Even as uncertain as those forecast may be, on the data that we will then incorporate in our planning processes to make sure that we integrate and how we build out the system, and build in the resiliency.

And I think that pretty much captures the points. Thank you.

(Applause)

MR. HOGAN: So, the last presentation of the day. I'll break the trend and deliver it from here.

So, thank you for the opportunity to participate today. And I thank the Commissioners, the agency leaders and the staff for convening this workshop on such a compelling topic.

PG&E appreciates the opportunity to share what we're actively doing to address these challenges and in a way that's serving our customers and our communities.

There's a lot of similarities in what my colleagues talked about that's going on in PG&E, so I won't duplicate any of what they spoke about.

I'm going to start by sharing how we're managing climate change resilience. A centerpiece of this strategy is around a multi-year risk assessment that we're conducting. And I'll also discuss some of our response to the current California drought.

So, as a provider of energy to about 16 million Californians, you know, we understand our responsibility both to reduce our carbon footprint, as well as to address the emerging needs to adapt to changing climate conditions.

Doing so is integral to our ongoing efforts to provide safe, reliable, affordable and clean energy. At PG&E, we've been investigating these potential risks for

quite some time, over the last several years. And we've identified a number of potential risks to our business, including flooding, sea level rise, temperature change and wildfire risk.

And as we work to address these risks, there are really four aspects to our approach. One is a robust emergency response plan and procedures, in response to things like storms and wildfires. And we look to continue to strengthen those processes.

We're actively engaged at the federal, state and local level on climate change adaptation and resilience.

Dr. Zamuda mentioned it earlier, I was proud to be down in D.C. for the kickoff, as one of the founding members of the DOE's Partnership for Energy Sector Climate Resilience. And we really look forward to that forum as an excellent forum for sharing best practices. And we look to have that directly inform on our work for identifying some of our vulnerabilities for extreme weather and climate change.

For some of the longer-term risks, we have a risk assessment process in place to prioritize our infrastructure investments.

A few folks mentioned earlier today, there's a lot of competing things for infrastructure investment, aging infrastructure, cyber security, physical security,

adaptation and the like. And so, we've put in place a fairly rigorous process for that infrastructure investment.

And, finally, we maintain an in-house climate change science team, a pretty talented one I believe, which regularly reviews the most relevant scientific literature and integrates its research into our risk assessment.

So, as part of our Risk Assessment Project, we pulled together a cross-functional team. It's conducting a multi-year, holistic assessment of the risk to PG&E's different natural hazards. And we call this group the Natural Hazard Asset Performance, or NHAP group. And it really covers all of our assets, primarily our electric and gas infrastructure, but also our real estate structures, as well.

And this process is really designed to identify impacts to our assets and then enable potentially affected business units to evaluate those risks and develop the necessary adaptation strategies.

A lot of this was progressing in our different lines of business, but wasn't always with a consistent set of assumptions. And it's one of the reasons we pulled together this cross-functional team.

So, what do we do here? This slide really shows

the structured process we're taking to conduct this risk assessment. We began this last year and we expect to complete the assessment of our assets by the end of this year.

We started by identifying a series of natural hazard scenarios, from flooding, to sea level rise, to heat storms. Our Climate Change Science Team helped define these scenarios, drawing on the latest science.

We're now in the process of reviewing our assets against these scenarios to assess which assets may be affected, so that we can develop the appropriate response plans.

The result will inform on our emergency planning and response activities, as well, as we continue to improve those.

Certain risks, such as wildfires, and my colleagues have talked about that. We've already completed that process. And as I said, assessing these risks is not new for us. But what is new is that we're really taking a holistic approach, structured and encompassing all of our assets, and using one set of standardized scenarios across all of our businesses.

All this fits into our strategic planning process and this timeline here shows that process. It's an annual cycle and we use it to define our company's

goals and strategies. A key component of that is the risk and compliance session, which is a key step where we identify the key risks for the organization and compliance issues for the business.

This NHAP work will fold into next year's risk and compliance session and will directly inform our strategy and our execution plans. And we expect our future scenarios -- our future sessions to assess and monitor our progress against that.

So, here's one of those scenarios, a flood. This scenario assesses our assets against FEMA's 100- and 500-year flood zone maps. These maps are the standard used for flood plan management nationwide.

It's difficult to say how frequently the 100-year storm may be. I know we call it a 100-year storm, but as we look out, and as many of us saw today, you know, are teams and others are predicting that in certain parts of our area the 100-year storm really could become more of a 1-in-10 year flood event. Particularly in certain areas, such as the Central Valley, by 2050. And that's how we're using this information.

At this stage, we've reviewed our assets against this scenario and are developing our longer-term risk response plan for our business.

We're also partnering to better understand the risks we face. We recently participated in the Bay Area Council Economic Institute Report, which forecasted about a $10.4 billion impact on the San Francisco Bay associated with this type of flooding scenario.

The storm that would be associated with this is larger than anything that's hit California in the last 150 years. But again, in terms of scenario planning, it appears appropriate.

So, surviving the storm. Here's a map that shows the projected flooding from the super storm report, as well as our substations that are at risk.

The report included our estimate that the disruption of six substations would cause an economic impact of about $125 million, and an impact that's mitigated by some of our redundancy and resiliency in our system.

As many of you know, our substations are interconnected through the electric grid and typically play a backup role to one another, to minimize customer service interruptions.

We also have a fleet of more than 20 mobile transformers that can be dispatched to support efforts like this or events like that.

Next is sea level rise, another scenario that

we've developed. And this chart shows the recommended guidance from our Climate Change Science Teams, associated with the projected level of sea rise through the end of this century. The projections are based on guidance from both the National Resource Council and the California Coastal Commission.

The scenario for our risk assessment is 24 inches, or 2 feet, which you see in the middle there, rise by 2050. Which is actually at the high end of the range for that year. So, that's the scenario that we've picked for sea level rise. So, we reviewed our assets against this scenario and are developing our longer-term response plans.

Because this is a longer-term risk, we're also engaging in numerous local studies and initiatives to learn more. And one example of that is we recently joined a kickoff event for a major sea level rise effort underway in San Mateo County.

I think just recently, earlier somebody mentioned the sea level rise planning database, as required under AB 2516. And we recently responded to that, as well.

Another scenario that we've looked at is heat storm. Heat storms are another risk that have kind of been with the electric industry forever. But our

scenario here is the July 2006 California heat wave, the worst heat wave to impact the State in the past 60 years. It lasted almost two weeks. The maximum temperatures in Fresno were over 105 degrees for 12 consecutive days. And over 110 degrees for five consecutive days.

And similar to the example that was used earlier for New York City, we weren't getting any relief at night, either. The min temperatures for five straight days didn't drop below 80 degrees.

So, both in terms of stressing equipment and customer demand for electricity, those are pretty significant.

So, in the near-term, we have a structured process to mitigate the impacts of hot weather on our system. You know, on an annual basis these are things that we study. We have a pretty sophisticated model, looking at our forecast, as well as our past summer data to forecast peak demand, and our system capacity, and where we have trouble spots.

But more broadly, we're investing significant resources to modernize our electric operations. This includes automated equipment that dramatically reduce the time to restore customers, when they do go out.

For heat events, our demand response programs

play a critical role. We continue to innovate in this area. I'm showing up there, is a new smart charging pilot that we have with BMW, that we believe is going to open up new possibilities for demand response, especially as electric vehicles become more ubiquitous in our service territory.

So, let's transition a little bit to the drought. You know, one of the longer-term risks we face is changing precipitation patterns. And as we know, we're in the midst of one of the most severe droughts on record. Almost three-quarters of the State has experienced either extreme or exceptional drought conditions.

And the last few years our precipitation rates have been some of the lowest on record. Temperatures are rising and, as we heard earlier, our snowpack has diminished.

So, in response to this, we're working vigorously and collaboratively to do our part. We've developed a Drought Task Force that's driving partnerships and strategies to help PG&E and the State respond to the drought.

We're coordinating with key partners, like the Fire Safe Councils, to prevent and respond to wildfires. We're also aggressively addressing vegetation impacts to

our gas and electric infrastructure, similar to some of the stuff that my colleagues up here spoke about.

We're also managing water in our reservoirs so that clean, affordable hydropower is available during the peak summer demand periods. One of the options, one of the things we're doing, that we have, we maintain dry-cooled power generation. So, our natural gas-fired plants are dry-cool technology, which uses 97 percent less water than conventional water cooling systems.

We're also significantly reducing water in our facilities. We exceeded our five-year company water conservation goal, which was a reduction of over 30 percent over the five-year period.

We've recently signed a water sharing agreement with San Luis Obispo County for our desalinization plant there to provide water in the case of wildfires in that area, and they need the water.

So, in the near-term, for our hydro operations, clearly we understand the scope of the challenges we face here. The Department of Water Resources' annual snow survey is critical to gauging the snow melt. And the most recent survey revealed the lowest snowpack measurement ever recorded, just five percent of average for that date this year. These conditions obviously impact our hydroelectric system.

Which for us, you know, we're the largest investor-owned system, hydropower system in the nation providing safe, reliable and clean energy for our customers. And hydropower, as many of us know, also enables to better integrate wind and solar generation into the grid.

In a typical year for us, hydro represents 15 percent of our power. Last year, in 2014, it was only 8 percent, and likely going to be around that or lower this year.

So, we're strategically managing our water supplies. Clearly, downstream fisheries and downstream user needs are a key component, as well. And one example is we're working with the Tuolumne Utilities District to manage the limited water supplies in that region.

We're also working closely with water agencies, first responders and regulatory agencies for individual regions to address the concerns, and develop mitigation plans for limited water deliveries. And we're continually analyzing our reservoirs and stream conditions for the system.

Longer-term we continue to collaborate with the U.S. Geological Survey and the California Department of Water Resources on research, and developing new models

to forecast runoff, to plan for potential snowpack reductions in the Sierra Nevada Mountains.

We're studying Northern California aquifers to better understand how they may respond to climate change. And we're embarking on new research with a CEC-grant-funded project, with the University of California and DWR to monitor snowpack, climate, soil moisture, and other factors in the Upper Feather River.

And then last, but not least, is we see a more resilient grid as also being a more sustainable grid, as well. We've kind of coined the term "the grid of things" to talk about all these different devices that are presently connecting to the grid, and will be in the future. Things like being able to seamlessly combine rooftop solar, and customer storage, along with consumer mobile applications, improving energy efficiency through information and automation. And providing better, greater visibility and control of the distribution system, a grid that was designed for one-way power flow, with all these devices. Creating a two-way power flow on that system requires more visibility and control. And we see that as a smarter, more flexible and more distributed grid will be a more resilient system in the face of the changing climate, and will continue to ensure the safe, reliable and affordable power for our

customers.

So, thank you very much for the opportunity and I look forward to any questions.

(Applause)

MR. ALEX: I'm not sure why I get to go first all the time but --

CPUC COMMISSIONER RANDOLPH: Because you're sitting on my right.

MR. ALEX: Okay, so thank you very much for your presentation. I have a few questions.

Diana, you talked a fair amount about risk and my first question is do you self-insure?

MS. DAY: Yes, we do have a self-insure.

MR. ALEX: And who bears the cost overall? Does that go back into rate base? How does that work? How do you spread the cost of problems, that we'll call climate-related costs?

MS. DAY: Uh-hum, in terms of insurance. I believe there is a rate component of that. I'm probably not the best person to address the specifics of that and I believe we have a pending, open proceeding on that matter.

MR. ALEX: Okay. And do you have -- you talked about looking at the risks. Do you have curves or, you know, future cost evaluations that you're projecting out

some amount of time?

MS. DAY: For some activities, we do. We look at things on a risk-by-risk basis. And our best predictive models are around our top risks, which is what one would expect. Wildfire risk, which I talked about, where we have a fair amount of data. Around other risks, such as cyber, and some of our gas systems, we have fairly good risk data as well. And we're looking to have similar risk models for other risks across our system.

MR. ALEX: And do you share that with the PUC and others?

MS. DAY: Yes, we do.

MR. ALEX: Okay.

MS. DAY: There are open proceedings, at the moment, around risk matters.

MR. ALEX: Great. Thank you.

Now, for SCE, I was interested in the consensus-driven data science statement. Is it your view that that doesn't exist right now?

MR. GRIGAUX: Yeah, I think what we're conveying is that there's a multitude of data sources today, and there's a lot of science, and a lot of discussion and a lot of studies being conducted. But I'm not sure that there is necessarily a consensus on sort of the --

there's a consensus, certainly, on the direction we're going in. But not necessarily on the specific data that we would need, that would be important for us to be able to incorporate in our long-term planning activities. That's really what that statement was referencing.

MR. ALEX: Okay, well, I'm sort of obsessed with data. I've spent 15 years, in various forums, trying to get a fair amount of data from the utilities, without a lot of success.

So, perhaps we can all agree that we need to share this data much more robustly.

MR. GRIGAUX: Yeah.

MR. ALEX: Okay. Now, I appreciated Patrick, at the end, talking about "the grid of things". A lot of the presentation, in some ways, was fairly reactive to the types of, you know, fire, heat and flooding. You have existing infrastructure and you need to protect it. Completely understandable.

I'm wondering if you take into -- when you think about "the grid of things", or smart grids, or energy efficiency, or distribution generation, or demand response if you're looking at costs of those particular activities and actions as compared to the climate risks posed to our existing infrastructure? Anybody who wants to respond?

MR. HOGAN: Sure, I'll start. You know, one of the things that we talk a lot about at PG&E is delivering today, enabling tomorrow. And so in a lot of ways, there are an awful lot of investments that we made on the grid. Some of the things I talked about on "the grid of things" that provide some immediate benefits today, whether it's safety, reliability, or affordability-related. But then, also, kind of set us up for the future.

You know, one future being, as I said on "the grid of things", you know, more devices being connected to the system, really being more ubiquitous.

But also with climate change, the aspect of resiliency is really huge. So, on both of those cases we're making investments that we're continually balancing, you know, what's the impact on today versus how much is it enabling tomorrow, and trying to make that balance.

MR. ALEX: Okay, and my last question for all of you is looking out ten years at your system, how worried are you?

MR. HOGAN: I'll start. You know, worried is always in the eye of the beholder. But me, personally, I do think we are taking the right steps. I think we have a lot of smart people in the various partnerships

that we talked about, with a diversity of opinion and really helping to decide on what are the things that we need to work on.

So, I think we're getting the right thoughts in there and I think we're putting together the right plans to be able to prepare the system for that.

So, as I look out ten years, there are absolutely challenges from a climate perspective, but I think we're fairly well covered and have the right direction

MR. GRIGAUX: Yeah, from an SCE perspective, I mean, I would essentially echo what Pat has said. I mean we are, today, investing a significant amount of dollars into the system to make it more robust, make it more resilient. I mean, upwards of $3 to $4 billion a year dealing with a lot of aging infrastructure, but really designed to prepare us for the future.

And as you all know, we've submitted, recently, our distributed resource plan to prepare for that smarter grid, the grid of all things, and really enable a variety of technologies to be able to be fully integrated through the grid. Which provides, really, a wider portfolio of solutions to meet the needs of the customer and ensure a more reliable system, as well as a safer system for our customers.

So, you know, we certainly are concerned with the direction that the climate is going in. I think, certainly, these discussions and the engagement that we're having amongst all these stakeholders and others in the industry is going to help us better prepare for that. But a lot of good things are happening, as well.

MR. CHO: I will say that there are concerns and I'd mentioned an example of renewables. And it's not just renewables, but it's really the diversity of the energy portfolio, whether it's distributed, rooftop, all of these things coming together.

And for us, for me at least, from a reliability stand point making sure that the gas is behind that to support that diversity and that dynamic load.

Well, one thing that I feel very confident about is that this is not an independent topic. What I mean by that is when we plan today, and before, around system reliability, system safety, system hardening, these factors are the things we consider all benefit the challenges we're talking about with respect to climate change.

I'll give you a simple example. As part of our Pipeline Safety Enhancement Plan, one of the things that we've been directed to do is develop a blueprint around detection. Technology, you know, that we can put in the

ground for stress, security issues. That is part of pipeline safety, but it has a direct benefit to some of the issues about having a smarter system for reliability.

So, I don't always see it as exclusive. I think there's a lot already embedded in what we do today.

MS. DAY: And I would add, it's hard to answer that question. It's hard not to be concerned, perhaps even distressed by the science and what it portends.

But in terms of strides that we've already taken towards resiliency on the electric system, the Borrego Springs micro grid we think is a great example that can be replicated in the future. The resiliency efforts that we've made at San Diego Gas & Electric in terms of hardening our system, the wood-to-steel program, for example.

There are things we are doing, that we feel very positive about. I think we feel better about where we are in wildfires, in terms of our system, today than we did five or ten years ago. But there's no doubt that the science is quite concerning.

CEC CHAIR WEISENMILLER: I guess I was gonna follow up with the general question for everyone of talking about climate or science. What do you disclose in your SEC filings, in a 10K to your shareholders on

the risk of climate change?

MS. DAY: There are some references, certainly, in the risk factor section, which is quite extensive, that addresses climate change. And also, in our Corporate Responsibility Report, where we talk in some detail about the risks associated with climate change. That's updated every year and a fair amount of internal work goes into -- an effort goes into ensuring that we address climate change risk in that filing. Probably in more detail than our SEC filing.

CEC CHAIR WEISENMILLER: Edison?

MR. GRIGAUX: I won't be able to really adequately address the question. I know we have a corporate focus on the general topic of climate change and how it impacts the system, and our preparedness to respond to those changes, generally speaking. I don't know specifically how we're addressing it in our 10K filings and that report, so I'll have to get back to you on that one.

CEC CHAIR WEISENMILLER: Yeah, PG&E?

MR. HOGAN: Yeah, so multiple ways. A couple of the key ones are we have an annual Corporate Responsibility and Sustainability Report, that's publicly available. And also, our responses to the Carbon Disclosure Project, which is an international,

not-for-profit organization, that requests this type of information. So, there's various areas, but those are two of them.

CEC CHAIR WEISENMILLER: Yeah, I was going to ask if each of you could submit to the record, later, examples of those specific risk assessments you have done.

I guess the next sort of general question is we've talked earlier about the Scripps scenarios that are developed for our climate studies. Do any of you use those risks -- those scenarios for your planning studies? And if not, why not?

Starting with San Diego which, at least, knows Scripps.

MS. DAY: I know we have a variety of different collaborations with risks. I'm not sure that I know the study that you're referring to. Although, in preparation for this, the meteorological folks made several references to both CEC and Scripps resources.

MR. GRIGAUX: I'm afraid I won't be able to satisfy that question, either, so we'll follow up on that particular topic.

CEC CHAIR WEISENMILLER: Okay, PG&E.

MR: HOGAN: So, I think I mentioned in my presentation, we have an internal Climate Science Team

and really looks at all available research that's out there, all available information, including the Scripps reports, and is using that to incorporate it into the scenarios that we've developed.

CEC CHAIR WEISENMILLER: It seems like one of the things that would help the Commissions, going forward, if we at least have some common set. Obviously, you can use different values for your internal planning. But getting to sort of a common basis for trying to look at some of the evaluations.

I think the other question I wanted to ask was that SMUD made the interesting observation, today, that one of the things they're doing is trying to capture infrastructure projects to make sure they can look at what adjustments should be made to that, considering climate change.

I was trying to understand, in your processes, how well you're set up as you look at various investments, which are quite large at this point, to make sure that we're considering for future-proofing those?

MR. HOGAN: So, I'll start on that one. So, it's absolutely part of our planning process. That fits into the answer I gave to Ken, earlier, in terms of delivering today, enabling tomorrow.

A couple of really good examples of that are three of our key substations, we had work to do in there to add new equipment, change out gear, and we took that opportunity to significantly raise that new equipment to the levels of sea level that I talked about here.

So, not something that, you know, that if we're replacing it today on a like-for-like or building on a like-for-like, odds are we wouldn't have done that. But, you know, looking at the science, looking at the scenarios that we've developed and the input to those scenarios, that's an example of where, you know, concrete have changed the project, itself.

MR. GRIGAUX: And so, again, long-term horizon climate impacts are not today as incorporated as we'd like them to be. But we certainly look at long-term projections of load and generation distribution and capacity throughout the system, in addition to our current understanding of our own vulnerabilities, within our own system. Capabilities of our own system to really design a sort of an infrastructural liability forecast and then prioritize how we make our infrastructure replacement or low-growth investments today.

So, it's incorporate in that way, but we wish to move in a direction of incorporating additional

scientific consensus-based data to enable us to make even better decisions going forward, to facilitate that long-term horizon.

MR. CHO: So, you mentioned about investments and what are we doing to incorporate the future? The biggest area for the pipelines is around pipeline safety at this time. And certainly, as I mentioned, we are incorporating technology that helps to really manage it in a smarter way. That we're not just reacting, but can manage it more flexibly.

Because the word I often use is that the system is much more dynamic, not just our system, but the system that uses the gas.

So as an example, SCADA systems, having technologies where we can talk to valves and control. I mean, those are things that are part and fabric of what we're doing as part of pipeline safety, which then benefits the very things we're talking about today.

MS. DAY: And on the electric side, Jimmie mentioned the recent South Bay Substation. That's a recent project that we just got through the permitting process, and it very much incorporated sea level rise as part of that planning process.

CEC CHAIR WEISENMILLER: If we were to try to take an estimate on when you would have your system

fireproofed and ready to deal with sea level rise, I mean in terms of rolling that out through your infrastructure, replacing vulnerable substations, you know, is that five years, ten years? I mean, does anyone have a sense or a goal of when you're going to be more or less future-proofed, at least those two?

MS. DAY: Yeah, I think for San Diego Gas & Electric, we're further along on the wildfires because of recent events.

With sea level rise, we are at the phase of collecting data and comparing our assets, and overlaying them on our GIS system. For some assets, we know they're close to the coast, but we're waiting for data to show.

So, my sense is we're not as far along as sea level rise. I don't have a time horizon for that.

MR. GRIGAUX: Yeah, for each of the specific risks that we've talked about today, I mean I can't specifically address that question. I mean, we've been on a $3 to $4 billion capital investment program for the past seven years, in the company, and have replaced, and upgraded, and hardened a significant portion of our transmission and distribution system throughout the service territory.

So, I can't quantifiably tell you how far along

we are and how much longer it's going to take. But we do see it as a long-term commitment that needs to be made to continue down the path that we're on.

Not to mention the fact that we need to prepare and facilitate the modernization of the grid and the incorporation of all these distributed resources. So, it's going to be an ongoing journey here for the next several years.

CEC CHAIR WEISENMILLER: PG&E?

MR. HOGAN: Yeah, I would -- I mean, I'm being very candid. This is a long-term journey, so ten years is probably not within that time frame to be fully proofed against it.

And I think also, you know, my view is over the next ten years that the industry is going to significantly change. The advent of distributed resources and how that impacts the grid, it will improve the resiliency. It will make kind of big substation events less impactful to the system than today. And so, you kind of start to ask yourself the question about, you know, do you make that substation 100 percent sea level rise-proof, versus being more resilient to be able to withstand if the event happens, being able to recover in different ways.

So, that's kind of the math and the logic that

we'll be following. But I do think this is a long-term view here.

CEC CHAIR WEISENMILLER: Yeah, my last question is, so what would be the most appropriate forum for the State to examine your plans in this area, and provide some policy guidance?

MR. HOGAN: So, I'll start, again. So, I think that my view again, the path that the CPUC has taken in terms of building risk, risk identification, and risk mitigation into the GRC process, I think, is the right approach.

MR. GRIGAUX: Yeah, I would echo that. And we have, by the way, I haven't spoken to it in my presentation, adopted a similar strategy at SCE, looking at a prioritized risk-informed decision making process, looking at a variety of criteria that drive our investments going forward and is in alignment with where the Commission has been going for the past several years.

So, that is a key forum. There's several OIRs, which I won't touch on here, that are really touching on many of these topics today. So, I think those are other forums that we can leverage as well, in addition to the other collaborative opportunities with the CEC and other key parties.

MR. CHO: I want to just echo what Pat said, and that is the GRC Risk-Based framework, I think is the way for us to address it. That's the venue.

Part of what we have to also factor in is, you know, what is the right investment? What's the right risk-to-cost assessment we have to make?

Certainly, if we put a station in five years ago, you know, do we want to go in and take that asset, which is a major investment, and build a new one? I mean, these are all considerations we have to take from a risk-cost perspective.

So, I think the Commission's Risk-Based GRC approach is the right one.

MS. DAY: And I would just add to that, that we find it immensely helpful to have forums, such as this, where we have the CPUC, the CEC and the Governor's Office all together, so that we can all get in the room to address these issues together. We find that quite useful.

CPUC COMMISSIONER RANDOLPH: I had a couple of questions. PG&E, Patrick, you mentioned your Climate Change Research Team. Is that -- do you have folks on that team that are focused on adaptation, specifically? And do you have opportunities for them to interface with the rest of the company to have these kinds of

conversations?

MR. HOGAN: So, it's a team, they're actually housed in our Advanced Technology Center. So, they have day jobs, so this isn't their one and only job. But, you know, it's a group of folks who have the skill set, and we've pulled them together. And we've had them in place for several years, now.

And part of their role is to, you know, keep tabs on the science as it's developing, and then help us to develop the scenarios that we've developed. So, it's not a full time job, just looking at climate adaptation, but it's a role and we weave them into a lot of our process teams.

CPUC COMMISSIONER RANDOLPH: And do any of the other companies have anything similar that you use, internally, to make sure you have the right information flowing?

MS. DAY: We have -- it has a different name, but similar to what PG&E has. It's a cross-functional team. We have meteorological scientists, and they're not hived off in a vacuum. They're closely integrated with our operational units, with our risk team.

We have 15 different departments that meet on a regular basis, led by our Climate Change Team, to address these types of issues.

MR. GRIGAUX: Yeah, we have a variety of groups, internally, that are looking at different aspects of this topic. Again, it's one that is still new for us, within Southern California Edison, in terms of proactively engaging the community and making sure that we develop a strong strategy going forward on how to adapt to these climate changes. And making sure that we sort of line up with the right science, again, and the right groups that can help us move this thing forward.

But, you know, we do have an Advanced Technologies Group that is looking at various technologies and the impacts of these types of changes on our system. We have our engineering group that is also incorporating that into its system designs today, system planning.

Not necessarily looking at long-term climate change impacts but, again, considering climate today and how it's impacting our system performance. And there are a variety of other groups looking at it. But not to the extent that we want to move forward to.

CPUC COMMISSIONER RANDOLPH: And so, do you anticipate that -- because you've mentioned a couple of times that you want to do more in this area. So, do you anticipate you will be doing more work in this area to --

MR. GRIGAUX: Yes. Yeah, so we have, as was referenced earlier today, we have engaged with the DOE and with the CEC, and just more recently with the Lawrence Berkeley National Labs in these types of efforts. So, yes, ma'am.

CPUC COMMISSIONER RANDOLPH: Okay. And then I had a quick question for SDG&E about your Santa Ana Wind Wildfire Threat Tool. Is that something that's adaptable to looking at wind issues in other areas, or is it specifically just looking at wildfire?

MS. DAY: Well, it's specific to Santa Ana Winds. It ranks Santa Ana conditions, basically on a 1 to 5 scale.

Is your question whether it could be geographically expanded or for other types of climate conditions?

CPUC COMMISSIONER RANDOLPH: No, I was just thinking in terms of providing data for other issues, like wind production, things like that. I mean, is it a tool that can be kind of modified for other purposes, either for that particular weather impact or using sort of the same methodology in other areas?

MS. DAY: I think some of the underlying data could be used. I'm not sure whether the index, itself, could be easily extrapolated. But I'd be happy to ask

that question of the team and circle back.

CPUC COMMISSIONER RANDOLPH: And then, kind of following up on Ken's question about data. It seems like a key issue in this area as you, hopefully, kind of ramp up your work in adaptation is sort of, you know, what are the opportunities to share that data with public agencies and, you know, both at the state and local level in terms of planning? And have you thought about that kind of differently in terms of thinking about long-range planning?

MR. HOGAN: So, I'll start. Obviously, a key area for collaboration and I think some of the things DOE and CEC lend themselves to that.

The balance we always have to think about is the security of the system, as well, and I think we all recognize both cyber security and physical security threats are also increasing. And so, you know, being quite careful on where our assets are and the vulnerabilities of our assets is a key balancing act, and any time we're thinking about sharing data.

So, as long as we have the right controls in place, you know, there's definitely areas where we've done that.

MR, GRIGAUX: Yeah, I guess I'm going reinforce with you the point Pat made, maybe just add a couple of

thoughts. I mean, the world that we're living in is changing in many ways. And, clearly, physical and cyber security threats is always a consideration for the utility, and one that we have to manage carefully.

That being said, we have all the right stakeholders in this room, plus a few others that are not necessarily here today. And so, it's just a matter of getting together and trying to figure out a way to mitigate those risks, address those concerns, ensure the proper confidentiality is maintained. And then share the right data that needs to be shared, to make sure that we can properly project the impacts of these climate changes on our system, identifying the vulnerabilities and being able to move forward with some good data.

MS. DAY: For our companies, in terms of the meteorological data and the data from our weather systems, we do share that fairly broadly. We certainly share it with researchers. And we publish a lot of our results to the public.

In terms of customer data, the issues that were just identified are ones that need to be addressed.

CEC CHAIR WEISENMILLER: I just had to follow up. I was going to ask you to submit for the record, later, how many climate scientists you have and how many

of those are focused on adaptation.

CPUC COMMISSIONER RANDOLPH: Commissioner Douglas, did you have any?

CEC COMMISSIONER DOUGLAS: No, no questions. Thank you.

CPUC COMMISSIONER RANDOLPH: Okay. Okay, we have three blue cards for public comment, is that correct?

MS. MC BRIDE: For the record, my name is Demetra McBride and I serve as the Director of the Office of Sustainability and Climate for the County of Santa Clara.

By way of a very, very brief foundation for this question, the County has just completed Silicon Valley 2.0, which was funded by the Strategic Growth Council. It's a regional climate adaptation platform.

The key resources produced under that are a nine-sector climate adaptation implementation guidebook, as well as a GO economic tool for decision support analysis.

The tool is a little bit unique in that it doesn't simply map the climate variable impacts, but we also went through an extensive period of mapping all of the key infrastructures, as well as critical assets within the community.

And then, the tool also has an economic assessment capacity to it, so that we can take a location, we can take a variable, we have two climate horizons. And then, you can also look at the fiscal, the revenue and the operational economic assessment impacts of those scenarios.

So, with regard to that and the question about data, it would be -- we had a varied sense of technical advisory committee, and PG&E actually served on that for two years.

In terms of data, knowing exactly where the assets and the infrastructure is located is one thing. But it's really, really important in terms of long-term planning to know what the sensitivity is, what the reach is of those assets.

Because you may have an asset in one area that serves a distant, but critical asset, in another area.

That information has been a challenge to obtain and we think that it would help not only with the near-term planning, but it would also help with long-term planning, as well as smart grid, and the "grid of things" planning. Thank you.

CEC CHAIR WEISENMILLER: Thank you.

Louis Blumberg.

MR. BLUMBERG: Thank you, Mr. Chair and members

of the panel today. I'm Louis Blumberg. I direct the California Climate Change Program for the Nature Conservancy.

I want to commend you for holding this workshop today. I think integrating this discussion and these activities into the IEPR is just what needs to happen. Climate change needs to become part of standard business practice. And I think we're hearing, today, some progress in that regard.

And I remember hearing that you convened, Mr. Chairman, at the CEC several years ago, about climate impacts on the energy sector. So, I think we can see today that there's been progress in moving from impact analysis to planning and some policy, as Dr. Bedsworth talked about with the Executive Order. And now, beginning to be action.

And I think that's where things need to go. We need more action in this realm and we're geared up to do that. And there is some good stuff underway.

I wanted to point out and echo what Dr. Bedsworth said about the role of natural resources, and the Executive Order directs agencies that natural infrastructure solutions should be prioritized. This is something that I mentioned to the committee several years ago about the role of nature, and the connection

of nature. And we're still a little frustrated with how the EPIC Program worked out, where we have climate research for the energy sector under EPIC, and climate research for the gas sector is somewhere else. And climate energy for the environment is somehow in the Fourth Climate Assessment.

And I know there's some effort to harmonize that and I would encourage you to do that. And I would also encourage you to look at the scope of EIPC because, as we've heard today and we hear repeatedly, there is an inextricable connection between natural resources and our energy system when it comes to climate change.

And using nature provides multiple benefits. It gets at those kind of winds that we've heard about. And a couple of quick examples.

We have, with water in the natural resources, we know that there's a water/power nexus. And so, the drought is affecting the energy demand because of the lack of water and the need to pump more water there.

With forests, we've heard a lot about fire. And I think I would encourage you not to go for proofing the forest. I don't think we're going to get to a fireproof forest. And so, we've learned over the years that it's the congruence of multiple extreme events.

It's, for sea level rise, what would the high

tide, with the series of storms repeated over days, the kinds of extreme events that are really going to overwhelm us.

And the kind of efforts that would be needed to proof something could be a lot of concrete could encase things in ways that we would not like to see, when we lose that natural benefit there. So, that's a note on that.

In terms of the coastal impacts and sea level rise, the Nature Conservancy has worked with stakeholders in Ventura County to develop a model, a tool there to look at future sea level rise.

The City of Oxnard looked at that and decided to put a moratorium or recommend a moratorium on power plant siting there. So, that's another application of that and that's yet to be resolved. But the people are paying attention to that.

So, there's a nexus there and the natural solution there would be to create more space, to do managed retreat, to use wetlands to buffer the coast. So, there's a role for wetlands, there's a role for water, there's a role for forests.

For endangered species, we have salmon and endangered species there in the siting of hydro facilities.

So, there is that strong nexus between natural resources and the energy sector when it comes to climate change and there's an opportunity to really pull that together.

And the last point, I would just follow on what Mr. Franco said about the atmospheric rivers. It reminds us that this is a global program, and a global problem that needs global solutions.

And a recent study from Princeton showed that the removal of the forests in the Amazon region would reduce the amount of precipitation that reached California through the atmospheric rivers. So, it's all connected.

An I would applaud your effort here, today, and encourage you to keep pushing them to do more. We all need to do more. Thank you.

CEC CHAIR WEISENMILLER: Thank you.

MS. MATHEWS: Before we start, I just wanted to make one short announcement. If there's anyone else in the room that wants to make a comment, you can still fill out a blue card and bring it to me.

And a reminder for anyone who is joining us by WebEx, that all's they have to do is raise their hand, and we will get their name so we can put them in a queue to start, as soon as finish public comment in the room.

CEC CHAIR WEISENMILLER: Great. Thank you.

Ben Davis.

MR. DAVIS: Thank you, Chairman and all of you for allowing me to speak before you today.

I wanted to say, first, I wish there was some magic way that I could take a transcript of this hearing and send it back to your counterparts in 1985, when the science showing we were heading this way already existed, and we weren't taking it seriously enough.

The politics of why we haven't taken it seriously enough, and it took us 30 years to get to a hearing like this is very scary. And I hope that it doesn't stop us from making progress on these important world issues in the future.

But I have a feeling that if I were alive 30 years from now, I'd be saying the same thing to a group like you, now.

That being said, I'm here to talk about nuclear power. I looked at your comments that were submitted prior to this, and the only comments you have are dealing with nuclear power and suggesting, basically, that nuclear power is an alternative source of energy that we can use to prevent global warming, or to stop global warming from getting worse.

I'm an opponent of nuclear power and I hope we

don't go that direction. But I was surprised to not see any mention of it or discussion of it on the agenda, today, because it is quite a prevalent issue globally right now. The whole idea that we have to use nuclear power to stop global warming is very prevalent and it's really dividing the environmental community.

Chairman Weisenmiller is aware that I've been attending IEPR meetings on nuclear power and carefully balancing the risks that you had mentioned at the beginning of the meeting, the risks and benefits of it, and trying to concentrate on the risks. And getting more information about the risks.

Now, that risk/benefit balance is going to be changing over the next 10, and 20, and 30 years as we face these issues that we're discussing today.

One of the reasons I'm here today is I have not been able to get information, that was brought up at the last Energy Commission hearing, on those risks from the Independent Peer Review Panel, which was appointed or at least started by the Public Utility Commission.

I was told by the Chair of the Independent Review Panel, in answering Chairman Weisenmiller's questions during that hearing, that they're going to have, and this is on the public record for that hearing, that they're going to have public meetings with PG&E to

discuss earthquake risks that the Independent Peer Review Panel couldn't -- didn't have information enough to discuss at the hearing. He couldn't answer your questions at that time and said they were having these public hearings within a few months.

They haven't had them and I started checking the day after that meeting to try to be part of those public hearings. I can't get any answers from anybody about when those hearings are going to take place.

I've contacted the Public Adviser's Office. They've not responded to my e-mails. I explained that the Chair of the Independent Peer Review Panel had told me these things and told me to contact the PUC. I can't get any information on this.

And I'm hoping that somehow, by appearing here today, with the people who are in charge of these things, I can get some aid in getting answers to this question about when the Independent Peer Review Panel will have these public hearings with PG&E on the earthquake issues concerning Diablo Canyon.

CEC CHAIR WEISENMILLER: Well, thanks for being here. I would note that one of the things that we've docketed on our website is a letter from President Picker, to PG&E, listing a number of issues they should deal with, one of which is that one.

MR. DAVIS: I'm not aware of that letter. But I will certainly look for it. Thank you for bringing it to my attention.

CEC CHAIR WEISENMILLER: Sure.

MR. DAVIS: Can I expect any follow up on this, now that I've brought this to your attention, that I'm not getting any responses from the PUC about these meetings or is there some way that I should follow up on it.

CPUC COMMISSIONER RANDOLPH: Why don't you leave your name and contact information and I will get the -- I'll talk to the Public Adviser's Office.

MR. DAVIS: Great. Thank you very much.

CEC CHAIR WEISENMILLER: Okay, we now have -- let's see, I'm not sure I can really do justice to the name. But why don't you come on up and introduce yourself.

MS. MAZZACURATI: The blank usually precedes my appearance. My name is Emily Mazzacurati. I am with Four Twenty-Seven. I'm the founder of Four Twenty-Seven. We're a climate adaptation and risk analysis firm based here, in the Bay Area.

I wanted to offer just a few comments related to some of the issues that were raised today, since we live and breathe those questions day in and out. And thought

I might be able to provide a few additional thoughts.

First, in referring to the Executive Order 3015, referenced by Dr. Bedsworth, I wanted to highlight the fact that it calls for an analysis of the economic impacts across sectors of climate change. And I think that's a very relevant thing to keep in mind for the energy sector.

Thinking, in particular, of the example that was set by Entergy along the Gulf Coast, and the analysis that they did of climate change, and they're own vulnerability, and now that could impact the entire economy and communities of the Gulf Coast. In thinking about when the power goes off, what are the impacts on the community? And I wanted to point that element.

A totally different topic, related to public health, which Kathleen Ave raised in her presentation, earlier this morning, comparing the initiatives that are going on across the country and mentioning, in particular, healthcare without harm.

We happen to work very closely with a group and with the Healthcare Council of Climate Change, with a set of hospitals, to help them understand how climate change is going to impact hospitals.

And, interestingly, one of the key issues that we're running into is being able to provide them good

information and data on the vulnerability of the grid that they depend on. And that's true in California and in other states, as well. And really being able to leverage the data that has been developed by national labs, like Oakridge Lab, and used in the DOE study on grid vulnerability to provide information that's useful to the end-users.

And so, I think thinking about how the data that the end-users need is very different from the data that the utilities and the national labs need for their own analysis, really opens the door to the ability to share some of this information.

And that takes me to my third point, having to do with how do we share the vulnerability assessments with the community, without putting anything at threat with regard to cyber security?

And I think if you think of what the end-user in those communities really need, it's not the details of where the facilities are, and what threats under what scenario. Any kind of rating or high-level assessment can already give them a lot of elements to help them plan for which one of their own assets that depend on electricity, which is everything, for which one of their own assets they need to plan or prepare for outages, or runouts, or any other kind of other vulnerability.

So, I think establishing this distinction between the amount of detailed data that's needed for vulnerability assessment by a technical organization, like a utility, versus the high-level directional pointers that are really all that's needed for the end-users in terms of adaptation decision making really opens the door for better information sharing.

Thank you.

CEC CHAIR WEISENMILLER: Thank you. I was going to note that last Friday, some of us were in a similar workshop, dealing with long-term scenario planning. And so, if you have some specific ideas, I'm sure Guido would love to get those suggestions on sort of the planning part.

The good or bad news is California is in a seismic area, so we have had requirements since the 80s for hospitals, in terms of backup power.

And I was just going to say, on a final point, one of the things that I thought certainly was a good message to our utilities here, was SMUD's message today that as they do their planning, they try to reach out to the community on helping the community-wide effort to come to grips with climate change.

So, of course, I'm hoping all four -- all three of our utilities here do that, also.

So, thank you.

MS. MAZZACURATI: Thank you.

CEC CHAIR WEISENMILLER: Is there anyone else in the room?

MS. MATHEWS: We do have one comment from Dr. Robert Green, on WebEx.

CEC CHAIR WEISENMILLER: Sure. Please go ahead, Dr. Green.

We might be having some audio/visual issues. Perhaps if you could e-mail your comment to our Public Adviser, she could read it into the record?

DR. GREEN: Thank you.

MS. RALFF-DOUGLAS: Do you want to do your closing comments and if the gentleman e-mails, we'll read it in and keep it in the record. But in the meantime you can do --

CEC CHAIR WEISENMILLER: Sure. And, actually, let's start with the announcement of when written comments are due?

MS. MATHEWS: If we can advance to the last slide, all of that information, the written comments will be due August 10th. But all of the information is on the very last slide.

CPUC COMMISSIONER RANDOLPH: Okay. Yeah, are we ready for that. Okay.

Well, thank you all for participating in this workshop. I thought it was very helpful. I am kind of -- the utility presentations talked a lot about things that were in progress, so I hope that that progress will maybe happen at a quicker pace and maybe you can share a little bit more about what's happening in the future.

The urgency that we started with this morning, with the first speaker, I think was instructive for all of us to kind of get moving and get this work done.

And so, I will ask my colleagues if they have any other closing comments?

CEC CHAIR WEISENMILLER: Well, I also would like to thank everyone for their participation today. I think that's probably one of the key challenges we all face is that the -- we are disturbing the climate in ways which are unpredictable. And I think that the question of saying, well, what are the implications of that -- you know, this is a relatively serious experiment that we're doing.

And I think we need to prepare and we need to prepare quickly, you know. And again, I think, as was pointed out, I think every year we've had an IEPR workshop on adaptation or on climate, at least. And I would note that of all of our IEPR workshops, this is

one of the rare -- the climate ones are always ones where there is applause after presentations. Normally, that doesn't happen, for those of you who haven't attended the other workshops.

So, anyway, that's partly from the scientific community. But we have to really be reaching out to our communities, to our citizens about the seriousness of the issues and how we have to get ready.

MR. ALEX: So, usually, we think it's a good thing when California has, you know, every kind of environment and habitat. In this case, we also have it all. We've got sea level rise, and snowpack problems, and heat problems, and health issues, and forest fires and, you know, the whole set of plagues.

And that creates a massive set of challenges. And the utilities are facing many of them. So, we very much appreciate the description of and the efforts by the utilities to address this.

I do have a couple of comments. One on data. Again, I'm sort of obsessed, but I have spent many, many years hearing the same story that utilities would like to share the data but, you know, we have this balance we have to do. And, therefore, in virtually every instance my view is that we have not gotten the data that we need.

LADWP, to its credit, has shared a massive amount of data with UCLA and the world has not come to an end.

So, I really, really want to move us forward on sharing of data, with protecting customer and private information. It is absolutely doable and we need to do it.

And, particularly, in the climate adaptation world, as one of the commenters said, we can do this at a high level, which will give us quite a lot of data and important information that we need to share.

A lot of people underscored how important it is to work collaboratively. I think we absolutely believe that. I think the State, the utilities, NGOs, everybody, we are in this together and we rise and fall together on this. So, I hope we can continue our efforts along those lines.

California has probably started more slowly on adaptation, certainly, than on emission reduction. And I'm among them. But now that we're moving down this road, I think we have the ability and the will to lead and I think that we will. So, thank you very much for participating today.

CPUC COMMISSIONER RANDOLPH: Commissioner Douglas?

CEC COMMISSIONER DOUGLAS: You know, I'll just be very brief. I'd like to express my appreciation to all of the speakers and presenters today. Today has been an extremely informative day. And it is interesting, we did go through a trajectory in the day from the kind of urgency of the first speaker, and then the sense of what can be done, what is being done.

And I think that we -- you know, we are making progress. This workshop wouldn't have happened ten years ago. It didn't happen ten years ago. And we can see that there's a lot of movement, interest, now, as well as, of course, the State's very strong leadership in mitigation, in reducing greenhouse gas emissions.

You know, I really think the actions that we take today in planning for, and dealing with, and making decisions informed by our understanding of climate science and the need to find practical ways to handle the changes that are occurring in California are going to have a huge impact on people's lives in this State. Not only in the long term, but in the near term.

So, I do think it's really important that we go from ideas to action sooner, rather than later, in this area.

So with that, again, I appreciate everyone's work in putting this together.

CPUC COMMISSIONER RANDOLPH: Thank you. Is there anything else we need to do, Kristin?

All right, thank you, everybody for participating and enjoy the rest of your afternoon.

(Thereupon, the Workshop was adjourned at 4:11 p.m.)

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I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were reported by me, a certified electronic court reporter and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

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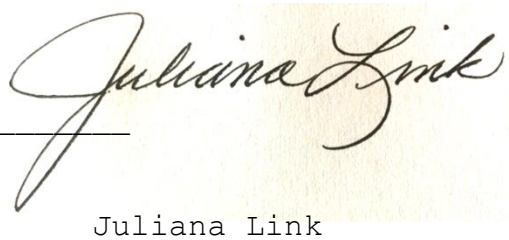

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