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BEFORE THE

CALIFORNIA NATURAL RESOURCES AGENCY

CALIFORNIA ENERGY COMMISSION

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2016 Integrated Energy Policy	)
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JOINT IEPR WORKSHOP ON

CLIMATE ADAPTATION AND RESLIENCY FOR THE ENERGY SECTOR

CALIFORNIA ENERGY COMMISSION

FIRST FLOOR, ART ROSENFELD HEARING ROOM

1516 NINTH STREET

SACRAMENTO, CALIFORNIA

TUESDAY, JUNE 21, 2016

9:30 A.M.

Reported By:
Kent Odell

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CEC Staff Present

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Kevin Barker, Adviser to Chair Weisenmiller

Presenters/Panel Members Present

Liane M. Randolph, Commissioner, California Public Utilities Commission

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

Kevin Hunting, Chief Deputy Director, California Department of Fish and Wildlife

JR DeLaRosa, Special Assistant for Climate Change, California Natural Resources Agency

Christine Curry, Deputy Director for Planning, Preparedness, and Prevention, California Governor's Office of Emergency Services

Dr. Leslie Ewing, Senior Coastal Engineer, California Coastal Commission

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Presenters/Panel Members Present (Cont.)

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Dr. James Strittholt, President/Executive Director, Conservation Biology Institute

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Larry Greene, Vice Chair, Alliance of Regional Collaboratives for Climate Adaptation

Neil Millar, Executive Director of Infrastructure Development, California Independent System Operator

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David Fink, Policy Director, Climate Resolve

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P R O C E E D I N G S

JUNE 21, 2016 9:30 A.M.

MS. RAITT: Good morning and thank you for coming today. This is the Joint Agency Commissioner Workshop on Climate Adaptation and Resiliency for the Energy Sector. It's part of the 2016 Integrated Energy Policy Report update process. I'm Heather Raitt, the Program Manager for the IEPR.

I'll quickly go over some housekeeping items. Restrooms are in the atrium. There's a snack bar on the second floor, under the white awning.

If there's an emergency and we need to evacuate the building, please follow staff diagonally to the Roosevelt Park, outside the building.

Today's workshop is being recorded through our WebEx conferencing system. So, parties should be aware you're being recorded. We'll post an audio recording on the Energy Commission's website in a few days and a written transcript in about a month.

We do have a very full agenda today and we're asking presenters to please limit your comments to the time allotted. And I'll be reminding folks of our time constraints as we go along.

At the end of the day we'll have an opportunity for public comments and we'll limit comments to three

minutes per person. If you would like to make comments at the end of the day, there are blue cards out by the entrance. Please go ahead and fill those out and you can give them to me.

For WebEx participants, we'll also be taking comments at the end of the day and you can use the chat function to tell our WebEx coordinator that you'd like to comment. And we'll either relay your comment or open your line at the appropriate time.

For phone-in-only participants, we'll take your calls after WebEx and the folks in the room.

If you haven't already, please sign in at the entrance to the hearing room. The materials for this workshop are all available there and on our website.

Written comments are welcome and due on July 5th. And the process for submitting comments is in the workshop notice.

And with that, I'll turn it over to Commissioner Douglas for opening remarks. Thank you.

COMMISSIONER DOUGLAS: Hi, good morning, everybody. I'm Commissioner Karen Douglas. I'm the Lead on the Integrated Energy Policy Report this year for the Energy Commission. I'd like to welcome you all here.

We have, as Heather said, a packed agenda. And

we have some really great speakers, so I'd like to thank all of our panelists in advance for being here, and for participating today.

We've got a number of goals for today. We very much want to go over the policy setting for climate adaptation, which is advancing rapidly in California with a lot of the work that is being spearheaded by OPR, and the Governor's Office, and implementation of the Governor's Executive Order. But that requires a very, very high level of interagency coordination and addressing cross-cutting issues.

We've brought a diversity of perspectives here today, both on the dais with us, and among the speakers. And we really hope this will be an opportunity for us to learn from all the speakers, learn from each other, and find innovative ways of moving forward and helping the State adapt to and address the issues presented to us by climate change.

Specifically, in the case of the Energy Commission, in terms of the electricity system, the energy system, and the natural systems that we are very much connected to and dependent on in the workings of our electricity system.

But as a State, broadly across the many areas and many agencies that have to deal with this issue.

So with that, let me ask Ken Alex for opening comments.

MR. ALEX: Good morning. Thank you, Commissioner Douglas.

The Office of Planning and Research is now, under SB 379 and SB 246, given some duties to deal with adaptation and resilience.

As we know, California has operated under AB 32 for many years, now, and that focus has been primarily on emission reduction. And the focus of the State of California, until very recently, has also and appropriately, I think, been primarily on emission reduction. But inevitably, we are not going to forestall and preclude all impacts from climate change.

And California, with 900 miles of coastline, and snowpack at the temperature gradients, and 121 degrees yesterday in Palm Springs, and all kinds of forest fires and forest fire potential, and drought, et cetera, et cetera, the inevitable consequence of all of this is that we must pay greater attention to resilience and adaptation. And we need to do so at all levels of government and we need to integrate it into our decision making. Certainly true as we think about our electrical system.

Louise Bedsworth, the Deputy Director of OPR,

will talk a little bit in more detail later about OPR's role. But just to give a preview, under SB 246, OPR is given the task of creating the Integrated Climate Adaptation and Resiliency Program, with a particular focus on coordinating state, regional and local responses. And that will have an emphasis under the law on climate equity. So, we'll pay particular attention to the most disadvantaged communities and some of their particular challenges.

We'll be developing tools and guidance, with State support, for local efforts in particular. And ensure that State planning, moving forward, will reflect adaptation and resilience issues. And that's a pretty big undertaking to look at all of the actions, particularly around infrastructure and planning that the State goes through as part of its process, and try to figure out the best places to integrate resilience and adaptation.

We'll also be running a clearinghouse of adaptation resources, which will be available to agencies and the public.

And, finally, we'll have an advisory council of experts providing scientific and technical support. And a lot of this, as you'll hear in a minute, will be done in conjunction with the safeguarding efforts run by the

Natural Resources Agency.

So, there's a lot going on. This IEPR process is a great way to start some of the discussion, particularly around the electrical and energy sector. And I'm very pleased to be here and to hear some of our speakers today.

COMMISSIONER DOUGLAS: Thank you, Ken.

Liane.

MS. RANDOLPH: Thank you, Commissioner Douglas, and to all the staff and the folks at the Energy Commission for putting together this workshop.

And I also wanted to thank Chairman Weisenmiller, who expressed his regrets last week, when I saw him, that he couldn't be here today, because this is an issue near and dear to his heart. And he's been working hard on this for a while. And so, I know he's sort of, you know, with us in spirit.

Last summer we did a Public Utilities Commission workshop on adaptation and it was a really informative day. And since that time, we've been looking at what the resources out there are on climate adaptation issues. We've been working with our investor owned utilities in gathering information from them about what their resiliency and adaptation efforts are. And we're eager to continue that work and dive more into detail.

So, with our rather impressive set of panels today, I'm really interested in hearing more information about how other agencies, and local agencies, and the utilities around the State are dealing with adaptation. And we are very eager to hear more information about the tools for analysis, as we look at how we are going to integrate adaptation issues into our proceeding process at the PUC.

So, thank you again to Commissioner Douglas for putting this together and I'm looking forward to the day.

COMMISSIONER DOUGLAS: Yeah, thank you very much. And it's really great that our Commissions are working together so closely on many issues, including this one.

JR, would you like to go next for Natural Resources?

MR. DE LA ROSA: Yes. Hi, everyone, and thank you. Thank you for being here. It shows the interest in adaptation. I think Ken did a good job of highlighting just kind of the framework and background.

But I'll add AB 1482, which was kind of part of an adaptation package of bills that were passed last year. They really provide a framework that is, you know, attempting to mirror the robust framework for our

mitigation strategies. And so, we're complementing that, now. And so, we have our climate actions, which include mitigation and adaptation.

And AB 1482 establishes Natural Resources Agency as the lead for Safeguarding California, which is the State's kind of adaptation plan, if you will, or report that really highlights, in ten key sectors, the types of vulnerabilities and impacts that we are expecting from climate change, as well as current actions. You know, what departments, agencies and sectors are doing to respond to these climate impacts.

I think there are a couple things, real quick, to highlight, and Ken touched on this. But I think there is a lot of momentum moving forward. Since the release of our first adaptation strategy, which was 2009, you know, we've experienced five of the largest 20 forest fires ever recorded. We've experienced a very severe drought. It seems like every year is a record breaking year in terms of temperature increases. And, you know, we're living in the reality, it's here.

And so, I applaud the Energy Commission's leadership. They are a sector lead for the energy sector in Safeguarding California. They are also a key partner and player in helping us better integrate and use climate science, and research. All of the previous,

the first, second and third assessments, as well as the fourth assessment, which is ongoing right now.

And this really provides the framework for in a way predicting the future. We're trying to get enough information to better understand and predict what future scenarios will look like so that we can come in and fill, and address, you know, what we're going to respond to. What our policy directions are going to be.

So, thank you very much. This is nice to be here.

COMMISSIONER DOUGLAS: Well, thank you for being here, JR.

And then, Kevin Hunting.

MR. HUNTING: Yeah, thanks, Karen. I'm Kevin Hunting, Department of Fish and Wildlife. I want to thank and applaud the Energy Commission for making this the topic of this year's IEPR. And this couldn't be more contemporary from our perspective, from a natural resource, climate change adaptation perspective. So, it's just great to be here and great to see this as the primary topic.

I just want to build on a couple of things that both Ken and JR said. You know, from my perspective, our department's perspective, as the trustee agency for fish and wildlife, and habitats in California, climate

change impacts are here. They're not a conceptual, theoretical impact for our predecessors to deal with. We're living it right now.

And I see it throughout our management and our planning programs within the department, you know, things are changing pretty rapidly.

We work very closely with the energy sector. Obviously, the Desert Renewable Energy Conservation Plan. We've been working on that, really shoulder to shoulder with the Energy Commission for years. And I think that's a great example of how you can integrate climate change adaptation and resiliency for natural resources, especially fish and wildlife, with the needs for valid and important renewable energy development in California.

You know, that said, that has been a point of conflict and I think we've done a good job, with our respective agencies, in managing that to the benefit of both.

I want to just highlight a couple of things that our department's working on. And this kind of relates to what I hope we can see as an outcome for today.

You know, we're very focused right now on our on-the-ground management practices for fish and wildlife in California. Our department owns and manages about

1.2 million acres in California. And, you know, we're already seeing of our management prescriptions kind of changing in a response way, you know, just even in the last few years.

The current drought that we've experience and we're entering year five, pretty clearly now, of the drought, has given us a glimpse into what a future California for fish and wildlife might look like.

Fish rescues, provision of habitat features and habitat values in areas where species don't yet occur, but will in the future. Population declines in some areas, population increases in other areas that were difficult for us to predict, but that we're now seeing.

So, I mean, that was a bit of a specter for the future, for us. And it gives us an opportunity to really think about resiliency and how we address resiliency looking forward in California.

So, just a couple of comments on some areas that we're focused on right now. We recently released our statewide action plan. That's California's blueprint for fish and wildlife, and habitats statewide. It was really built on climate change, the impact of climate change adaptation to address those impacts. It was highly focused on that.

The energy sector is one of the companion plans,

which are the focused implementation pieces of our State Wildlife Action Plan that occurs, you ought to take a look at that.

Another product that we recently released, that we're already putting into practice is a statewide assessment of terrestrial vegetation in California. We've been lacking kind of some of the baseline information we need against which to judge climate change impacts and changes. And it's -- this vulnerability assessment gives us, in conjunction with the fourth assessment, with the other tools, the ability to baseline and predict, in a more certain way, what the future might look like for fish and wildlife, and habitat in California.

So, this will be a cornerstone of future planning. This will be a cornerstone of our management planning, our land management plans, our future public dollar investments in wildlife and habitat in California. It's a very important piece and I'd encourage you to take a look at that.

So I'm hoping, you know, obviously, this creates a forum for a discussion and sharing ideas, which I think is critical right now. It's the right forum for doing that. And I'm hoping we can focus on, at the end of the day, practical policy and practical processes

that we can implement in the near future and agree upon that are important for the energy sector and for natural resources in California. So, I look forward to the discussion.

COMMISSIONER DOUGLAS: Well, thank you, Kevin. And as you've said, we've worked really closely together over the years. And I've learned a lot from that interaction. And one of the things that I've observed is that on the energy side there's actually a lot we can learn from looking at how agencies with a natural resources mission are dealing with climate change.

Because while we are all living it, some of us are living it in more real time, and more intensively than others. And certainly, when you're planning for and trying to understand species across the landscape, climate change is just fundamentally front and center.

So, it's been a great partnership. And we have, actually, someone from the CDFW staff later today making a presentation that we're looking forward to as well.

So, as Commissioner Randolph said earlier, the Chair was not able to attend today and he was quite torn about it, and he was very sorry to miss this workshop. He was actively involved in working with my office on preparing the workshop, on planning it, on talking about topics we would cover. His advisers were very involved

and gave us quite a bit of help, and ideas, and information as well, as we put this together.

Kevin Barker, the Chair's Adviser, is on the dais with us today. And Kevin, do you have opening comments?

MR. BARKER: Thanks, Commissioner. I've got a brief statement from Chair Weisenmiller to read to you.

As the Commissioner said, he, unfortunately, got called to stay a little bit later than he had anticipated out in Denver, Chairing the Regional Grid Workshops out there. So, another important topic as we kind of move towards a more future-looking energy grid.

So, I'd like to first, I guess, thank everyone's participation and Commissioner Douglas for hosting this workshop.

So, climate adaptation is a very important topic. And once again, he's sorry for missing the workshop.

We know from the fourth climate assessment that California is changing in many ways. It's getting hotter, we know that from the recent heat wave. It's getting drier, we know that from the recent drought that we've experienced.

And we're experiencing worse winter storms, less snowpack and a lot more.

We're also experiencing subsidence in the Central Valley from groundwater pumping, as well as an unprecedented tree die off from the drought, heat and bark beetles.

Utilities have vast networks of infrastructure, pipelines, transmission lines, distribution lines, water conveyance systems and more. Billions are spent each year expanding, maintaining and modernizing these systems.

Investing in resilience and adaptation is critical as well. Moving forward we must incorporate both mitigation and adaptation into our policies and planning.

So with that, that's the brief statement that he wanted me to read, but let's kick it off to you, Commissioner.

COMMISSIONER DOUGLAS: Thank you, Kevin.

All right. So, with that, I'll turn this over to Heather.

MS. RAITT: Great. So, our first panel is on Statewide Approaches to Climate Adaptation in the Energy Sector.

And our first speaker today is Louise Bedsworth, from the Governor's Office of Planning and Research.

DR. BEDSWORTH: Great. Well, thank you,

everyone, for inviting me here this morning. I'm going to speak about some of the legislation that was touched on in the introductory remarks and, also, Executive Order B-3015, from which a lot of that legislation stems.

And then I'll close with some thoughts on implications, and what we can learn, and how we can help and contribute to work in the energy sector.

I always just like to start with the reminder, which I think JR touched on, as well, which is that our adaptation and resilience work is very much a part of an integrated climate strategy and tied to our efforts to reduce emissions, and our investments in research. As demonstrated through the fourth assessment, with a real focus on supporting preparing for impacts.

And we have important documents in each of these areas that really guides our work at the State level. But they all work very closely together and I think, increasingly, we're seeing the overlaps and the need to integrate, and think holistically about our approach to climate change.

In 2009, we had the first climate adaptation strategy, with a real focus on the State. And I think since that time there's been a really important evolution and development at all levels. At the State,

at the regional, at the local level. So, we have a really robust set of actions that are happening right now. Where, at the State level we've really been focused a lot on doing sector-based vulnerability assessments, developing implementation action plans through a directive from the Executive Order.

But at the same time, we have a growing network of regional collaboratives that are focusing in geographic areas on how we prepare for the impacts of climate change. And a lot of this is supported, also, by a number of quite local place-based initiatives and increasing directives to incorporate climate change into local plans. So, into general plans, local coastal plans, et cetera.

And so, I think the framework of legislation and the Executive Order reflects this much more integrated, across-scale approach to thinking about climate adaptation and resilience.

So, I'll start with Executive Order B-3015, which was signed by Governor Brown in April of 2015. And I think it was notable in a number of respects. And one is on this integration of mitigation and adaptation. This contained our directive to further reduce greenhouse gas emissions for our 2030 target, and combined that with a very comprehensive set of steps to

prepare for climate impacts. And I'll focus more on the latter.

And so it laid out, really, a number of elements focused on updating Safeguarding California regularly, developing implementation action plans. So, to take that document and turn it into a set of steps of how we're going to implement it. And developing a tracking mechanism so that the Natural Resources Agency can see how we're doing, and be transparent, and report back on the implementation.

It also included a statement that we should start considering climate impacts in all of our planning and investment. And that we should consider current and future climate change in all of our infrastructure investment and in the State's five-year infrastructure plan. And in doing that, to use full lifecycle cost accounting in the infrastructure investment decisions.

And so, it also had some specific call outs on principles of adaptation that we really need to think about. And this includes prioritizing natural and green infrastructure, working with local and regional partners in doing this work, and in protecting the most vulnerable populations in California, and incorporating equity into our work.

So, OPR was tasked with forming a technical

advisory group to assist State agencies in implementing this Executive Order. And that has gotten underway in the past several months.

And so this technical advisory group is really trying to do two things. One is sort of help to provide more guidance on what we should be planning for. But touching on those specific call outs and principles of adaptation, there's some important changes in how we plan that need to happen as well. Which is how do we plan under more uncertainty and how do we work in a regime where we're coordinating a lot more across agencies and across levels of government?

So, the technical advisory group includes over 50 members from inside and outside State government. It's been -- it started with a bit of a core group of about 40. A number of people have joined. We have a network of sub-working groups that have brought additional people in. So, it's been really exciting to see the interest and the engagement we've had around it.

We have formed a number -- six sub-groups to focus on some of these specific elements of the Executive Order. So, really, to develop specific guidance for State agencies on climate scenarios. So, using our climate projections data, trying to help provide guidance on what we should be planning for and

how to work under and interpret uncertainty. Provide guidance there.

To develop metrics for tracking how we're doing. So, what are the metrics that we should be thinking about, linked to our implementation. Action plans for safeguarding, but then thinking more generally about the State's population and communities becoming more resilient.

We have a group focused on communities, equity and vulnerable populations. What are -- and what each of these groups are really trying to do is develop a set of principles that could work across State agency planning and investment to address these issues. So, thinking about principles, as well as tools.

We have a group focused on infrastructure, including tackling the issue of full lifecycle cost accounting, and how big is that box that we're drawing. Is it a purely economic analysis or are we trying to capture more externalities. And so, using this group to really think about what's practical and how can we move forward with that.

Very closely related, but a separate working group, is also addressing natural and green infrastructure. In both of these groups, we're trying to provide definitions. What is infrastructure? What

do we currently think of as infrastructure? What do we want to think about as infrastructure in the future? What is natural and green infrastructure and how does that work with our sort of traditional gray infrastructure?

And then we have a group focused on local and regional coordination. And all of this also sets up a really nice framework and it's really intended to do some foundational work for thinking about implementation of the legislation from last year.

So, we're imagining our final product to come out by the end of this calendar year, which would be a type of a guidance or action plan for State agencies. So, it's very much a first step to what we see as a living document that can continue to evolve as we get new science, as we have new information and observations. And as we have this ongoing technical advisory committee, through Senate Bill 246, that can continue to work with this document. But this is sort of a focused effort to put a number of elements down on paper.

So, in looking at the legislation, a number -- all of these bills were touched on in the introductory remarks. I think what's worth calling out is really what they do is they focus on the State. They focus on

local and regional actions. And then they bring them together.

So, Assembly Bill 1482 is focused on safeguarding and it has elements on the five-year infrastructure plan, so codifying those activities.

Senate Bill 379 incorporates climate change into local general planning and local hazard mitigation planning.

And then Senate Bill 246 creates a mechanism to integrate this work at the local and regional level with State agency actions through the Integrated Climate Adaptation and Resilience Program.

It includes updates to the Adaptation Planning Guide from -- by the California Office of Emergency Services. And calls out for coordination via the Climate Action Team. So, another opportunity to not just integrate local and regional work, but to bring this into a lot of our discussions around our mitigation efforts, as well.

And so, finally, I'll just close with what I think are some links and sort of implications for the energy sector. And I think one is just having this group sit down together and really think about what should we be planning for, and how do we help provide guidance within the range and the uncertainty that we're

looking at. And where do we need to be thinking, you know, in the most protective senses? Where can we think about apply different types of solutions, et cetera?

I think also, on considering climate change in all of our planning and investment. And I think a few things have emerged, particularly this week, as we've been looking at the heat storm in the southwest. Which is we've been very focused on the impacts that climate change are going to have on our infrastructure, and thinking about making sure our power plants aren't underwater in 50 years.

But it's also really important to keep in mind the role that infrastructure plays in supporting our communities and providing community resilience.

So, in an instance with extreme heat, where there's extreme strain on the energy system, that puts vulnerable populations at risk under a heat event. And so, I think that will be some important considerations that will come out through this work.

And then, finally, really the work on how we integrate local and regional considerations into our planning and investment in a meaningful way, and work across all levels of government. So, thank you.

MS. RAITT: Thank you, Louise.

So, our next -- sorry. Okay, you did it just in

time and now I can't turn this off.

Okay, so our next speaker is -- I don't think she's here, yet, so if it's okay, we'll move on to the third speaker. So, I'd like to invite Deborah Halberstadt, from the California Natural Resources Agency.

MS. HALBERSTADT: Thank you. I don't have a Power Point, so I'm just going to sit here at the table. Thank you very much for having me here today. I am the Deputy Secretary of California Natural Resources Agency for Coastal and Ocean Matters, and also the Executive Director of the Ocean Protection Council.

And I've discovered, in my short time with the OPC, that not many people know what it is. So, I'd like to give you just a really quick snapshot of who we are.

The OPC's role is to protect California's coast and ocean. And we take a sustainable ecosystem-based approach to protecting, conserving, and restoring, and managing the ocean and coastal resources.

We work very closely with California scientists to enhance scientific understanding of the ocean and coast. And we work on issues ranging from marine protected areas, to ocean acidification, marine debris, fisheries, sediments and, most importantly for today, sea level rise.

One of our roles is to collaborate with our sister agencies and departments across State government and to convene interagency working groups on the wide variety of topics affecting ocean health. And one such group that we work with regularly is COCAT, the Coastal and Ocean Climate Action Team.

The Ocean Protection Council members are the Secretary of Natural Resources Agency, the Secretary of CalEPA, the State Lands Commission Chair, which rotates between Controller and Lieutenant Governor, and two public members, as well as two ex officio members from the Legislature.

So, in terms of what we are working on regarding sea level rise, in 2011 the OPC Council adopted a resolution on sea level rise, highlighting the urgency of reducing greenhouse gas emissions as early as possible in order to limit the damage from sea level rise.

And the OPC resolution resolved that State agencies and any non-State agencies -- or non-State entities implementing projects or programs on State property or funded by the State had to consider the risks posed by sea level rise to those projects.

The OPC, at that time, also committed to supporting regular guidance updates for State agencies

based on current scientific understanding.

The resolution recommended that State agencies follow the science-based recommendations in the latest version of the sea level rise guidance document. And I'll be talking more in detail about that guidance document.

It specifically recommended against relying solely on the lower third of the range of sea level rise values. And instead it suggested looking at potential impacts and vulnerabilities over a range of sea level rise projections, including the highest values. And it recommended against -- or it recommended avoiding making decisions based on sea level rise values that would result in high risk to public health, safety, infrastructure, et cetera.

So, as I noted, the OPC developed the State sea level rise guidance document, in coordination with COCAT, to summarize the status of science and to provide recommendations to agencies in evaluating sea level rise.

OPC's sea level rise guidance document provides projections of sea level rise for different time periods and provides recommendations for assessing potential impacts from sea level rise. It was initially developed in 2010 and it was last updated in 2013, after the

release of the National Research Council Report, which was funded by OPC and the CEC.

Since then, Governor Brown, as you heard from Louise and from Ken, issued Executive Order B-3015, which further directs State governments to factor climate change, including sea level rise, into State agency planning and investment decisions.

In addition, as Louise discussed more in detail, the Legislature passed AB 1482 and SB 246. And so, the existing guidance document recommends taking into account the feasibility of projects to adapt to rising sea levels and the consequences for underestimating the risk of flooding.

It includes a wide range of sea level rise for various time frames, up until 2100. But importantly, it includes this statement that I'm going to read verbatim.

So, it says: "It is important to note that the National Research Council Report is based on numerical climate models developed for the Intergovernmental Panel on Climate Change, IPCC, for the assessment report, which do not account for rapid changes in the behavior of ice sheets and glaciers and, thus, likely underestimates sea level rise".

So, since the release of the 2013 guidance document, there have been observations and improved

modeling of ice melt dynamics that are pointing to an increased likelihood of faster ice melt scenarios.

OPC is collaborating with OPR in developing a new update to the State sea level rise guidance document to reflect this evolving science and to give guidance on how to plan for sea level rise under this new scenario.

We're also working very closely with OPR in updating the guidance document to make it relevant to local governments, given the recent mandate.

So, we used to talk about sea level rise in centimeters, and then inches, and then feet, and now meters. And you'll hear later today from Dan Cayan about the results of one method that he's been working on for estimating the probabilities of sea level rise.

Unfortunately, because we can't look into the future, we can't know the true probability distribution. And we are hearing from ice melt scientists that there is deep uncertainty about how fast the ice sheets will melt. Since we don't have high confidence in the ability to develop these precise probability distributions, we recommend putting additional weight on the possibility of a worst case scenario.

We've heard from sea level rise expert, Bob Kopp. In his testimony for the National Climate Assessment in March he said, "We don't know the true

probability distribution. If you don't have confidence, maybe you also want to consider putting additional weight on the possibility of a worst case scenario. If you think there's a 90 percent chance that experts know what they're doing, then maybe there's a 10 percent chance that the probability that we could be in is bad as the worst case scenario".

So, we are working closely -- we are part of the Policy Advisory Committee for Dan Cayan's research project. We're working closely with him and we'll continue to engage the Technical Advisory Committee for this project to develop scenarios for assessing sea level rise in a way that addresses uncertainty, presents information in an actionable framework.

We're also looking at -- in that context, looking at the use of scenario-based planning and using adaptation pathways to conduct management with the chancing shoreline.

So, decisions for infrastructure near shorelines, as the CEC and the CPUC will be making soon, will require ongoing monitoring and adaptive management.

Part of conducting adaptive management is building into the framework accountability to ensure ongoing delivery of critical services. So, questions that you might want to consider would be at what level

of flood or erosion do you want a facility to come back with a plan on how to adapt?

Will you need to protect in place or will you move to a safer location?

How much time do you need to evaluate options, to raise money, to obtain regulatory approval for the next phase of the project to be more resilient.

And it's prudent to conduct planning investments, knowing that we're in a new world with changing shorelines.

Scientists tell us that based on the emissions in the atmosphere, we are now committed to multiple meters of sea level rise. We are locked in. And the big question is how fast the sea ice is going to melt.

We're shifting into a framework of asking how long do we have to solve a difficult problem. And this is something that Susie Moser is going to be talking about in far more detail. That's her framing of the question and you'll hear more from her this afternoon. But I think it's a really helpful way of thinking about the issue.

So, in addition to thinking just about sea level rise and siting infrastructure, such as energy facilities, you're going to also have to take into account vulnerability to storms and extreme events like

tsunamis. So, you need to consider not only the sea level rise zones, but also exposure to flooding from extreme events.

Moving now to safeguarding, as Executive Director for the OPC, I am the ocean and coastal lead for the Safeguarding Plan. And there is -- I think that the number one recommendation in the 2014 document, related to oceans and coasts, is hazard avoidance for new development.

And so that language is quite long and I have it all written here. So, JR had asked me to get this into the record. So, do you mind if I just recite or do you want me to just summarize it?

COMMISSIONER DOUGLAS: You could just -- we'll take note of it or you could put it in, in writing.

MS. HALBERSTADT: Oh, we'll send it separately, okay.

COMMISSIONER DOUGLAS: Thank you.

MS. HALBERSTADT: Yeah. So, just hazard avoidance is the key there.

We're also working on implementing AB 2516, which is the Sea Level Rise Planning database. And so for that, we've surveyed certain entities, including several utilities. We had 14 of the 15 utilities who surveyed responded. And of those, nine said they had no

information to report as to what they're doing on sea level rise planning, and five had some information.

So, that is about it. We will continue to provide science to inform State agency action and we look forward to continuing to work with the CEC to develop informed actions to increase resiliency to sea level rise. Thank you.

COMMISSIONER DOUGLAS: Thank you, Deborah. That was very helpful. And as you pointed out, the question of how to assess potential sea level rise in infrastructure and especially coastal power plant licensing proceedings is something that is far from theoretical right now. So, this is really helpful policy background to get on the table in a forum like this one.

So, Heather, go ahead.

MS. RAITT: Okay, great. So, thank you, Deborah.

Our next speaker is Dr. Lesley Ewing from the California Coastal Commission.

DR. EWING: So, good morning, Commissioner Douglas and others, members of the public here. Thank you so much for inviting me to come here today. I'm here on behalf of the Sea Level Rise Team at the Coastal Commission, and also Commission staff.

And we have been very involved with the issues of sea level rise now for many years. I started at the Commission in 1989 and my initial assignment was to do a guidance document on sea level rise. So you can tell, it's been a multi-decadal process for us, as well.

I will give you a brief presentation on what the Coastal Commission does, something about the Coastal Act. Why California's concerned about sea level rise, specifically the Commission. What we've done with our guidance that was recently adopted back in August. Steps within that guidance document to deal with planning and permitting.

Then examples of some of the things we're doing with adaptation and some of our next steps.

The mission of the California Coastal Commission is to protect the coast for present and future generations through careful planning and regulation of environmentally sustainable development, strong public participation and education, and effective intergovernmental coordination.

So, this meeting today is one of those examples of trying to look at intergovernmental coordination. I appreciate being here.

The Coastal Commission derives its authority from the Coastal Act. It was a public act, passed

through proposition in 1972, Prop. 20, and then enacted into law in 1986 -- 1976, excuse me. The three components of the Coastal Act call for authority to govern or to review -- not govern, sorry -- grant coastal development permits, look at federal consistency, look at local coastal programs, and to then have partnerships and working groups to look at how to protect the coast.

The idea of federal consistency is a very powerful one. Because when the State developed a coastal program, it enabled the State to look at federal projects for consistency with our coastal program. That doesn't mean we have approval, but we have consistency review and can deem federal projects either consistent or non-consistent with the Coastal Act. We can object or find them consistent.

So, it gives the authority to look at many coastal activities that are beyond, often, just State and public activities, and private activities, but also into the federal agency activities.

And then we have a strong partnership with local governments. The local coastal programs were set up so that there would be a partnership between the State agency, the Coastal Commission, and local governments to coordinate on how to protect the coastal zone. And

local governments have the authority to develop their land use plans, ordinances, which become part of the local coastal program that are their way of implementing the Coastal Act at the local level. And they have the permitting authority for most of the projects that go on within the coastal zone.

Now, 86 percent of the communities within the coast have developed local coastal programs. Many of those were done back in the 1980s. We're now working with those local governments to update those because they didn't include issues like sea level rise, often, or include them as much as they needed to be included.

So, we've had several grant programs. We're on our third round of grants to help local governments fund and develop those updates to the local coastal programs.

In general, the Coastal Act has policies that address public access, protection and enhancement of marine resources, issues developing the land resources, water-oriented recreation, access to the beach, access to the coast, development in general and the protection of scenic and visual qualities within communities.

The coast has been and will remain a really vital part of the California economy and our way of life. It provides us recreation, housing, energy facilities, industry, transportation. It's a many-

faceted area and one that we need to deal with in many different ways.

But as several of you have already said, climate change is happening. And many of the concerns associated with climate change and sea level rise along the coast, erosion, permanent inundation, and temporary flooding are occurring, have been occurring, and will continue to occur. With sea level rise they will be worsened in most cases. But it's not a new issue for the Commission. It's just of new importance and relevance because of the concerns we have over the acceleration of these concerns, of flooding, and of inundation and erosion that will occur with rising sea level.

Because of that, we put together a sea level rise guidance document that has consolidated much of what the Commission had been doing for a number of years. And developed that into a one place to go and understand all the concerns we have about sea level rise, what we're trying to do, and how we are advising, guiding local governments and individual applicants on how to address sea level rise within the projects or planning that they bring before the Commission.

Like any document, it's got an introduction. We've got guiding principles. We talk about some of the

sea level rise science, consequences of sea level rise, how we address sea level rise within local coastal programs, or LCPs. How we address sea level rise within the coastal development permits. What some of the adaptation strategies are. What's the legal context for how we're doing this. And then next steps.

I'm going to quickly go through some of these parts. A lot of this is not unique to the Coastal Commission. We are working together with other State agencies, with various executive orders. I realize some of these are out -- not out of date, but we need to add a lot more initials, a lot more numbers because there's been so much activity going on with climate change and sea level rise.

But we view our document as being consistent with and in more detail than, in some cases, the Safeguarding document, because it deals specifically with the Coastal Commission, and the local governments and the applicants before the Commission will be doing.

Our guiding principles are to use science to guide decisions, to maximize protection of public resources, recreation, access, and sensitive coastal habitat areas, to minimize coastal hazards. They can't be completely avoided in many cases, but try to minimize those through careful planning and development

standards. And then maximize coordination.

We have a number of areas in which we've gone into more detail. We talk about using best available science, scenario-based planning. So, you don't plan for just one thing, but you plan for a range, the highest, to the mid-range, and then perhaps the low range. But plan for a full range of options of sea level rise. Do so with precautionary principles and look at environmental justice.

There's also the principle that perhaps property owners should assume many of the risks associated with their development. We want to protect the public trust that's a State resource for everyone.

And the coordinate regionally. Sea level rise is not a property-by-property problem. It will be a regional problem and it needs to be dealt with on regional scales. And then, we want to maximize public participation.

The planning steps that we have are to look at what amount of sea level rise are you expecting and then what are the risks that are going to be associated with that. Not just the water level that comes with that, but the changes to erosion, the changes to flooding, the changes to inundation, with big storm events. Flooding is not a problem unless you've got a large storm. So,

we've always taken that as an important part of how you look at flooding.

And then what are the assets you have that could be at risk? What are the development plans that you might be proposing that would be in risky areas? And then, identify what you can do about it. What are the adaptation steps you can do?

If it's a planning project, then what are the adaptation steps you can incorporate into your project? If you're doing a local coastal program, what are the adaptation strategies you write into your zoning ordinances and your implementation ordinances? How do you incorporate this adaptation into what you want to do and make it reality and then put it in to either your permit, or your local coastal program, and work with staff.

It's an iterative process. Because working with staff, working on these projects is going to be an ongoing basis.

Many of you may be familiar with these steps. Those first three are essentially developing a vulnerability assessment and then the second -- the last three are developing sort of your adaptation plan.

And we look at these in the planning horizons for the project, itself. When we talk about looking at

vulnerability for sea level rise, it's going to depend on the life of the project and the sensitivity of the project. We recommend using the numbers within the NRC document, within the State guidance document to look at those for sea level rise. And figure out what your level of risk might be. What are you going to be vulnerable to over the time you expect your development to be there?

If you're talking about a lifeguard station that might have a life of 20 years, you might look at a lower amount of sea level rise than if you're concerned about putting in a new power plant, a new bridge, a new road, or a wastewater treatment plant.

We know, too, that there's developing science that maybe the numbers that were in the NRC report might be low. It's looking into the future and so we're trying to keep track of the new science so that we know what the potential risks might be in the future of underestimating sea level rise.

And then, once we've determined what the possible risks might be, what are the adaptation options you have? A lot of our guidance deals with those adaptation options, going through and listing what ways there are available to communities or to individual projects to implement adaptation throughout either the

beginning part, middle, or end of the project. Adaptation is not a single step, but it can be an iterative process throughout the development of a project. Perhaps based on triggers, based on risks, based on something that will say it's time to change how we are doing things. But we anticipated ahead of time we might have to make some changes.

So, in the guidance document we go through and we have a number of different Coastal Act policies, coastal development hazards, public access recreation, habitat, agricultural resources, water quality and supply, archeological and paleontological resources, and visual quality.

For each of those, we talk about some of the various goals that we want to implement. Like, for this goal, plan and locate new development to be safe from hazards, not required protection over its entire lifespan and be protective of coastal resources.

But within that, identify a number of adaptation options that could help with that goal. This is not a do everything on the list. It's ideas. It's intended to stimulate other actions that might be better than what we've listed. But trying to get people thinking along the idea of adaptation.

It's sort of a new concept for people,

especially looking at development. Because we think of once something is built, it's done. And that's not really full adaptation.

So, our next steps are going to be starting to implement the guidance that we passed. It was adopted by the Commission in August of 2015. And now, we need to start helping and finding out best ways to go about using our guidance and developing adaptation policies.

I bring up energy facilities as one example because there are a number of facilities along the coast that are going to be relicensed soon, up for reconsideration, whether this is the right site for them to be located? Whether this is where they should stay for the next 30 years, 60 years, 100 years?

And often we don't have answers, but we would like to work with you to find ways to best let the energy system within California adapt to those things that will be happening in the future, over which we have, to some extent, very little control.

And so, how can we adapt to climate change, to sea level rise in particular, and maintain the energy systems that we need.

We've already worked on a number of options for adaptation over the years and this is not new to us. It's just a new framework in which it's being presented.

We've developed setbacks over the years that have been very effective. Here, you can see where development went in before the Coastal Act, and then soon after the Coastal Act with a setback. Those homes are still safe, while the homes right at the edge are a little concerned about how long -- how much longer they'll be able to stay there.

We've been working a lot with Caltrans on new road projects, so that those road projects can be designed now to take into account sea level rise into the future, into the 2100 and beyond. So that this bridge, one of the I-5 bridges down in San Diego County, they're being replaced, they're being rebuilt. The lower bridge is the design that has been done to accommodate the amount of sea level rise we expect in the future to allow the habitat to move. So that the nursery areas for fish and wildlife communities, so that the habitat that's provided by wetlands and environmentally sensitive habit will be able to continue to expand, to go inland and upland, rather than be constrained within a very narrow channel.

And we've worked with Caltrans on opportunities to relocate. It's not something that happens overnight. This is the double Sly Tunnel. It took 25 years for that project to go into effect. But we worked over time

with Caltrans to find ways to incrementally make that happen.

We understand adaptation is not just a one-size-fits-all. There can be different strategies for different locations and hazards, different ways of protecting resources. And the effectiveness of adaptation is likely to change over time and place. Some adaptation options will work wonderfully well in the North Coast and they will not be effective in the City of Los Angeles.

And for the most part, most new projects will need to consider hybrids and multiple strategies for adaptation and multiple ways of putting those into effect over time. And we're hoping to be able to work with individual property owners, applicants, communities, and other groups that want to work with us on finding ways to better adapt and implement adaptation for climate over time, and for sea level rise in particular.

So, thank you very much for your attention. And this is how you can see our Sea Level Rise Guidance document, if you want to.

COMMISSIONER DOUGLAS: Thank you.

MS. RAITT: Thank you. Next is Christina Curry, from the California Governor's Office of Emergency

Services.

MS. CURRY: Good morning, Commissioners and members of the public. I really appreciate you including CAL-OES this morning to talk about energy policy and, specifically, climate adaptations, and some of the things we have been looking at and have been doing. Hopefully, to meld this all together with our world of disaster management and the things that we're facing right now in California, in real time, and then what our responsibilities are to anticipate and improve that condition over time. And how I think this opportunity with all that the State has done with climate adaptation to direct us, as a State, to consolidate really is helpful and going to improve a lot of things. Even outside of climate, for us, that reduce risks in communities.

So, just a little bit about what we do. Hopefully, this isn't stating the obvious. But our office is responsible for responding to disasters, at least when things rise to the State level, which a lot does. And directing the action of other State agencies. So, we really work with everybody that's here in the room, speaking, and otherwise working on climate adaptation in that real-time mode, as well, to leverage those resources and things that communities need to, you

know, bounce back, to respond, to protect lives in times of emergency.

So, we have a very efficient and effective system to do that. I think, looking at climate adaptation down the road, we're not going to be able to, you know, always going to need that. We're always going to need to be ready to respond.

It's really what we're doing to anticipate what those impacts are going to be, how that affects our resources available to respond, and their capabilities they need to have. At the same time, trying to reduce the risk ahead of the impacts so that we can, you know, again, help our communities to withstand things that may rise to the level of a disaster in the future.

And part of our job is to also work outside of disaster response. So, we do have a responsibility to prepare, provide guidance and tools for communities to prepare for disasters.

And what we call mitigation in our world, which is risk reduction, and recover from disasters. So, when they do happen, there's a long road that follows that. Still coping with a lot with the fires from last year, for example. To make sure that things are at least put back to some sense of normalcy and creating those opportunities to improve and reduce those risks, while

we're doing the recovery from events. So, we have a lot of opportunities to do that. A lot of opportunities to work with everyone here to be as effective as we can be.

This is just a snapshot. I couldn't possibly fit all the pictures of doom and gloom that California has faced. This is just recent. Maybe since 2014 up to the present. A lot of things you recognize.

But I did want to include, you know, we are at risk to earthquakes. I thought I was going to be the only one here to talk about earthquakes, but somebody mentioned tsunami already, so there is a nexus even to that.

And acts of terrorism. We have to be ready for intentional harm that can be done. And it's important, when you're looking at resiliency and all the things that that means, you know, unfortunately, we have to look at that as well. Cyber security, acts of intent, you know, those trying to do harm and disrupt is a huge consideration for the energy sector, as you well know.

Not to mention, you know, the other types of known disasters, like the fires, the oil spill. Aliso Canyon, you know, was a lot of things, and it was also an emergency that had to managed in real time.

The landslide in Pacifica, you had a photo of that. You know, the El Nino threat that we thought we

would have this year for the south really didn't pan out, but we still had impacts to storms in many communities and Pacifica included.

So, you know, we're ready to those. We respond to these. Some of these rise to the level of federal assistance and dollars. Some of these are managed by the State. Regardless, California needs to be ready, and is, to face emergencies, climate related and otherwise.

And so as I kind of keep talking and talk about resiliency, you know, we have that in mind and how we improve, and what are the foundational things that help us be ready for these, and help us withstand these events that really span all the different kinds of hazards we face.

So just I put this up here as a comparison of one of the things we look at for seismic risk. This is a map of shaking intensity. So, red is bad. Blue is better. Yellow and orange are in between. And the map on the left is the Napa earthquake from 2014. So, you can see the concentration. It might be kind of hard to see. The shaking was, obviously, Napa, Vallejo, that area right around there. And then, you know, a little bit outside of that zone. Very devastating for those communities that were impacted and suffered damages, and

disruption, and less so.

And then we compare that to what we've modeled as a similar -- using similar science, as a shaking map, if the 1906 earthquake was to repeat itself today, and you pan way out, look at how far and wide that same demonstration of shaking. That's a huge impact. That's millions of people.

that's really going to test and even exceed our ability to respond, you know, maybe as effectively and quickly as we were able to with Napa, but only because the scale of the event was so different.

So we, at our office, have to be ready for both magnitudes. So again, as we're employing techniques to be resilient, to reduce risks, we have to keep in mind what we could face, maybe much, much less frequently, as well as what we actually face with greater frequency. And, you know, kind of toggling between those two notions is a difficult thing. But we do have to plan for what I call the catastrophic.

And again, as we're making investments and looking long range and short range, you know, being ready and being capable to deal what the maximum end cap can be is, unfortunately, a reality in California. So, I just wanted to show that comparison using earthquake as an example of how we need to be able to scale up our

abilities.

So, a couple of ways that we would look at our slice of the world, I would say for resiliency is part of that is being ready to respond. Again, disasters are inevitable, they're happening to us right now. We need to be able to understand what we have to be able to do.

And the way we look at that for response, because it would be difficult and impractical to have plans on the shelf for every single hazard, there's just too many of them. It's just most things are common in terms of what we have to be ready for and what's impacted, regardless of what causes the issue, earthquake, act of terrorism, flood, fire, you're going to need people, first responders to come out there and save lives and protect property.

So, we do that as an all-hazards approach. We have generic national frameworks for responding and all the different federal assets that would come into play. We have a generic State emergency plan that articulates how we handle disasters.

Then, we do have a few which are hazard-specific, and these are those big scale, you know, like that 1906 earthquake level. Because especially with earthquakes, we know that they will come with little or no notice, and we need to know how we're going to

organize and manage the needs of communities during those times. So, we have done some hazard-specific planning in those cases where we're just really not going to have a time to get organized. We're going to need to kind of know how that organization's going to look right out of the gate.

So, that's really one element of resiliency, being ready to respond. And that shifts, as we understand more what we may face in the future, to respond. So, the drought has been mentioned today. It's a good example. It's the disaster that keeps on going. We've been in it for years, now, and really have been managing it like an emergency. With that, you know, kind of army of people. You know, Kevin and his agency, the water agencies to, you know, at the community level, dealing with people who are literally out of water. While at the same time investing and facilitating resiliency against future drought. You know, all of that happening. And it's taking a lot of energy, a lot of resources to do it because we're facing it now.

But that kind of pulling it all together, and bringing our investments and our energies together to really be resilient to that condition as a permanent one in the future is what this is all about. You know,

that's what the adaptation policies and the leadership that California is really kind of getting us ready to be in that mode. Not as a crisis but, really, ahead of the game because we understand that's a realistic new condition.

And you take drought and you multiply that by everything else, you know, more floods, drier conditions, more heat, you know, and you can see how this is starting to translate into the world of emergency management. Because that's just really what the future looks like and we have to translate that into our products and into our approaches to planning for disasters, as well.

And so the way we've done that, and I think Safeguarding gets the prize because now everybody's mentioned it, because it truly is where a lot has come together. And then, with the package of legislation, the executive order that were promulgated more recently, I think really positions California very well, at least from our office's perspective, to integrate and understand the risk of climate. And then, push that into our approach to, in our case, all hazards emergency management.

So, one thing that Cal-OES oversees is the mitigation plans at the local level for all hazard risk

reduction. And these are required by communities. If they want to tap into FEMA dollars, Federal Emergency Management Dollars, post-disaster, or even dollars that become available for risk reduction, they have to have these plans in place. So, it's an important component where we can really push in the State's climate adaptation strategies, and all the tools that have become available for adaptation, and have it appear in these mitigation plans.

They're updated every five years, so a little more frequent than maybe general plans, or other activities at the local level. So, it's a great opportunity. And I think our communities have been appreciative that so much has been done for adaptation that, you know, it's very comprehensive, and understandable, and things that we can give them the tools, too. So, when they do these plan updates, they're not having to reinvent the wheel, necessarily, if we've done our job, to make these things translatable and understandable.

One of those ways we've done it is the Adaptation Planning Guide that was mentioned earlier. So, that's a toolkit that really allows communities, who are preparing their local mitigation plans, to import, translate the latest climate science and package it in a

way that meets the formatting and other requirements for their mitigation plans.

And then we put Cal-OES has been a sector lead for emergency management or safeguarding. And all the actions that have come from that.

And so our next statewide mitigation plan will have an ever increasing portfolio of climate adaptation included because of the work that we did in safeguarding.

So, it was very important for us not to create an emergency management version of climate adaptation. That wouldn't make sense. It would just increase I'm sure what already tends to be confusing at the community level with different State programs. But rather to make all these things reflect one another. And, you know, where we're updating safeguarding, then that folds nicely into our next State mitigation plan. And, hopefully, we'll do the same in return when the next mitigation plan at the State level is done by our office. It will inform safeguarding in the future. So, we're really working hard to make those things interoperable.

And I think that's a big strength that we have, the adaptation that helps us with all hazards in emergency management.

Another strength I think, and as it pertains to energy, is that we work together all the time. We are consulting with the Energy Commission, with the utilities, with just about all those types of disasters that I showed the photo of earlier. Just about safety, reliability, supply, and all the things that communities need in a disaster and for us to be able to restore, or ensure we're protecting. You know, we have that relationship and we are working together all the time.

I think where we're seeing improvement and I think the series of directives this year is really going to help, is at the ground level and making those investments ahead of time.

We have grant programs, to be honest, that we're pushing down to communities for risk reduction. It's our responsibility, as I see it, to make sure that we're coordinating with all the other agencies that are planning and have opportunities for investment.

So, at the ground level, where that all comes together, not unlike drought, where we've managed it in emergency mode, to make that the norm where we're really kind of at the community level translating, and having this all make sense.

And I think the clearinghouse will be a big part of that. The TAG, you know, all those things Cal-OES is

part of. So that we can help, again, at the ground level to make sure that these are packaged together. And as communities are making decisions and trying to understand, you know, what guidance to follow that we've done our job as a State to bring that all together. And, you know, if there can be a benefit for seismic, and a funding stream for that, how can that help with other things. You know, I think that's really where our efforts are and should be placed so that we can improve that.

And again, I think climate adaptation and all of the State's initiatives have really helped us lead the way.

We have connections, of course, with similar functions in other states and nationally. They're all looking to us, in California, on how we're figuring this out, and how climate adaptation strategies can affect emergency management. So, you know, what we do here obviously really does span much, much farther and wider than California. So, it's exciting to be a part of.

And I hope that provides just a little snapshot of how we're looking at this and how, hopefully, we're partnering effectively with everyone else in this space. And look forward to being part of the dialogue going forward.

COMMISSIONER DOUGLAS: Well, thank you. And I just have one really quick question. And that is, you know, I think I heard you say that you're really integrating climate adaptation into everything you do. It's not a separate silo of what you do, it's part of your overall emergency management. And you're looking at leveraging, you know, integrating it in everything you do and leveraging multiple funding streams where possible, to get multiple benefits.

Is that a generally accurate kind of a summary?

MS. CURRY: Yeah, absolutely. First of all, it's consistent with our mission already, because climate adaptation or the risks associated with the future of climate are risks to disasters that we have an obligation to work to, you know, maybe prevent. But at least buy down the impacts of those.

So, it's a complete and natural fit with our agency. And we are making it part of everything we do because everything we do in some way, and should, effect emergency management. So, our fire fighters, and law enforcement, and people who are kind of working in those specific areas need to understand what the future will bring, because it has a direct impact on their business and their ability to continue to protect communities and protect property. So, it's very much a fit and very

important for us.

And, actually, like I said, it's an opportunity. Because we have done so much to understand this and to consolidate State efforts it's actually, you know, makes -- unlike anything I've ever seen in terms of bringing the State family together, and regions and communities. So, we see that as a very positive thing.

And climate, what we do for climate adaptation truly, I believe, when we get to the heart of the techniques that communities need to be resilient, spans a lot more than climate. There's not a lot in the hazard world that doesn't have a nexus to climate. But when you look at seismic, when you look at resiliency against intentional acts, I do believe that we can leverage these strategies and these techniques to even help us with those.

So, we want to see how this can inform all of our lines of business and effort beyond climate, as well. So, it's exciting to be part of.

COMMISSIONER DOUGLAS: Thank you.

MS. RAITT: Thank you, Christina.

So, next, we'll hear from Guido Franco, from the Energy Commission, and Kristin Ralff-Douglas from the CPUC, and they'll be our last speakers for this panel.

MS. RALFF-DOUGLAS: Good morning. So, when the

PUC and the CEC were working on our chapter of the Implementation Action Plans, we got together also with DGS to cover the building section of this as well.

As part of this document, we created an Adaptation Working Group which includes several of the other agencies that are here today. It's chaired by Commissioner Randolph at the PUC and Chair Weisenmiller at the CEC. But it also includes OPR, and CNRA, and OES to participate in the group.

The action items that we put into the Safeguarding Plan are action items that we're focusing on specifically in the short term. But we're going to work with DOE, and the IOUs, and the Publicly Owned Utilities on the vulnerability assessments and resilience plans that they agreed to do as part of their memorandum of understanding.

Craig Zamuda is here and he's going to talk more specifically about what the DOE Climate Resilience Partnership is. But as part of that, there were two very large deliverables that the IOUs have agreed to do. And actually, I understand they're here to talk more about what their plans are.

But in addition to that, we're also looking at the -- extending, perhaps, the opportunity for the Publicly Owned Utilities to participate, as well. SMUD

is already a partner and it would be great to see other California utilities as part of this.

And then, another key action item is to collaborate on research needs and efforts within the commissions. There's a lot of things that are happening in both commissions. And, in fact, the energy agencies, but also the emergency agencies, and OPR. So, we were looking to have this group be more collaborative in terms of ongoing discussions.

In addition, Guido's going to talk more about the climate, sea level rise scenarios. This is an effort to try to encapsulate what is going to happen in a way that the utilities can start planning around these events. You know, which levels of sea level rise do they use, temperature ranges, that sort of thing.

And then the last thing is to encourage cooperation and collaboration among the utilities and the various regional climate resilience collaboratives. There's a lot happening at the regional level, the city levels, the county levels, and we want to be sure that the utilities are really participating in a very thoughtful way with that.

So, I'm going to go quickly through some actions we've taken at the PUC and then Guido's going to talk about things at the CEC.

So, in January we issued a guidance document to the utilities where we highlighted what they had already agreed to do through their DOE Climate Resilience Partnership obligation. And we highlighted the fact that we were really interested in their participation and providing a very robust vulnerability assessment.

Very quickly, the DOE Partnership called for identifying key climate risks to study. Part of this opportunity, obviously, is to be looking at localized data, looking at the different time frames that we're talking about, whether it's 2020, 2050, 2100. These are obviously all going to present very different challenges.

Part of the issue is do you look at the worst case scenarios or the best case scenarios? Obviously, we plan in this State for earthquakes, but we don't necessarily plan for a 9.0 or a 10.0, so how much up the climate scenario risk chain do we go.

And we were looking, obviously, at the inventory of assets and the potential effects on each one of these assets. And one of the things we were hoping the utilities could provide is the performance level of each of the assets, how they would respond to various climate change issues but then, also looking at them when there were multiple things happening at once. So, more

scenario planning.

Identify and obviously prioritize the vulnerabilities so that we can be addressing the most important things first.

And then, DOE had asked to have a magnitude probability of impact. So, what is the magnitude of something happening and the probability, and so we can identify those things that have the highest probability and the highest magnitude, first.

In the guidance document, we asked the utilities to expand that request from the DOE and include several different aspects here.

In the first place, the current and the future generation, and distribution assets that are not owned by the utility. As you know, many utilities don't own all of their generation assets. These are contracts. They're owned by homeowners. These are things that are not directly within the control of the utilities, but are very much a part of their system. And keeping an eye on what the vulnerability of those assets are is very important to the situation.

And in fact, the entire supply chain for fuel and critical parts is key to understanding how quickly the utilities can get back up online, or how they can protect their customers from not going offline.

In 2006, I understand there was the heat storm, transformers were going down, and there was a concern that there wouldn't be enough transformers available to replace all the ones that were broken. So, these are supply chain kind of issues that we need to be looking at.

In addition, there's a lot of issues with other industries, such as telecommunications, and water sectors that we need to be aware of. If the telecommunication sector goes down, that's going to bring down part of the energy sector and vice-versa. So, these are conversations we should be actively having.

In addition, we need to look wider than just the assets of any individual utility. We need to be looking California wide. And in fact, we need to be looking regionally because the heat storms that we're experiencing in the southwest are going to directly affect California, as well.

And any water shortage, resources from the northwest are also going to directly impact us. So, a more regional perspective is needed.

Energy and management procedures are something that the utilities are looking at all the time with regard to drought, and wildfire, and earthquakes. But

this is something that needs to be expanded to include more of the issues that are going to happen as a result of adaptation.

We'd also like them to look at vulnerable communities. There's a lot of different things that need to happen for specific communities, that we need to be aware of at the outset.

And also, institutional barriers within the utilities. How are they dealing with their own management system? How are they dealing with their own flexibility and adaptability to incorporating adaptation at the highest levels and then throughout the organization?

So, I'm going to turn it over now to Guido.

MR. FRANCO: Thank you, Kristin. So, the Energy Commission is leading several activities, mostly related to the science part of the overall effort.

So, for example, we have Commission developing -- the development of climate scenarios and several scenarios that will be discussed early this afternoon, so I'm not going to say more about that.

But we also supporting several projects looking at the vulnerability of the energy system and what adaptation options are attractive.

And we're also mixing, or combining, or

coordinating mitigation, reducing greenhouse gas emissions with adaptation. One example is we have a research project with LBNL, Lawrence Berkeley National Laboratory, UC Berkeley, UC Irvine and E3. Both the three groups or the four groups are looking at how the energy systems should evolve in the next 34 years, to 2050. Again, weight produces drastic grid options, so greenhouse gas emissions. While at the same time we're developing a system that is less vulnerable to climate impacts.

In addition, we are funding projects that are part of California's fourth climate assessment that will be released to the Governor and the Legislature late in 2018. We have a number of projects on that.

One example is a project with ICF, a consultant company. They are working very closely with San Diego Gas & Electric. Brian is here, I just talked to him and I'm waiting for your presentation because I think it's going to be wonderful. And it's going to be wonderful because it shows how the researchers can work with the utilities to develop robust adaptation strategies.

And in this case, they are looking mostly at the effect of wildfires, how wildfires will affect the operation of San Diego Gas & Electric.

And we have other projects like that, but we

don't have time to talk about them.

So, my last point is what I said before, where we asked all the researchers to work very closely with the utilities, and with the CPUC. And was showing us an example of work that was just finished. The report is still in the Commission, but we already received technical comments from the Pacific Gas & Electric. It's a study about the vulnerability of natural gas infrastructure in the Sacramento and San Joaquin Delta.

And UC Berkeley was able to show that, yes, there are vulnerabilities there. PG&E was convinced that, yes, this is the case, and they developed their own strategy of how to deal with that.

The good news is that we have early on found out these vulnerabilities. PG&E has determined what they could do. But the good news is that it will not happen tomorrow, it will take time. So, there is time to incorporate this type of adaptation activities in the current activities, when improving infrastructure for the energy system. That will -- in my opinion, will substantially reduce the cost of adaptation for the energy system.

Other activities that we have been coordinating or leading, Louise talked about the creation of a technical advisory group, by OPR. We are coordinating

and leading for her the Climate Scenarios Group. So, we see this as a huge opportunity to make sure that we don't have climate scenarios for the energy sector, one set of scenarios, climate scenarios for water, climate scenarios for energy, et cetera, et cetera. The idea is to have one set of common scenarios and scenarios that will be used for research and long-term planning for all the sectors of the economy.

As part of the fourth California assessment, we are also coordinating the adoption of climate scenarios, ancillary scenarios for all of the studies. The good news is again that we are involved, too. So, hopefully, we will not have completely different climate scenario for the fourth assessment. They will be highly compatible with what will be adopted by OPR, for the guidance document, and also what will be adopted for the Energy Commission and the California Public Utility Commission for the energy sector.

Finally, I think my time is almost over, is that I mean we have EPIC funds to study the energy sector -- the electricity sector. We have PIER Program funds to study the vulnerability of the natural gas sector. But before we didn't have any money to look at the petroleum sector. What happened with our final, petroleum pipeline, et cetera, we received a one-time allocation

of funding from the Petroleum Violation Escrow Account, so Susan Wilhelm is leading that effort, you know, to look at the vulnerability and adaptation options for the petroleum sector.

I think we'll end with that and thank you very much.

COMMISSIONER DOUGLAS: Thank you, Guido. And I think that we've got some time for questions. I wanted to start with one, which that Guido talked about the value of having a single set of climate scenarios that we can use across different State agencies and across sectors, so that we don't have to start the day with the question of, you know, what scenario shall I use today. But at least we have that answered and we're on to how do we use it and in what way.

But I guess my first question is how do we go about getting one set of scenarios and how do we keep them updated, and at what frequency might they need to be updated.

And I don't know, maybe Louise, I don't know if you've got kind of the birds eye view on the picture of getting to the goal of State climate scenarios?

DR. BEDSWORTH: Yeah. I mean, I think -- well, I think we hear over and over what should we plan for? Just give us a number. And I think we all know that

it's going to be very hard to give a single number.

So, I think trying to tie as closely as possible to the regular climate change assessment process makes sense because that is a large, integrated, coordinated investment in research. So, I think that's helpful and that's what we're looking to right now.

I also think the question that Deborah brought up is really important, is trying to also take that information and present it in different ways that is relevant for different audiences.

And I think some of the framing, and there's definitely a need to say, okay, what should we plan for, and give the range, and some guidance on how to think within that uncertainty.

But I think also flipping it around in other ways, thinking about how long do we have to plan for X type of an outcome can be very helpful for a local planner, for instance.

And so, I think that that's a conversation that we're starting to have, as well.

So, I think it's not going to be the silver bullet of plan for this. Because the example was given, if you're building a lifeguard stand or you're building a power plant, your tolerance of risk is different.

So, it's never going to be that single number.

But I think trying to provide that context, and I think the commitment the State has made to research is really important, and just continuing to do that work. And also, to be really thoughtful and learn from the experiences we have.

For instance, with the heat wave this week, we've been reaching out to researchers in Southern California to just get a sense of were people out there measuring to see how well did this event map to our projections of heat island index? You know, and what can we learn from the events that we're having right now, which can also go in to help provide more guidance.

MS. RANDOLPH: What kind of information do you feel that you need from the utilities, either publicly or investor owned, that would help inform your sort of research development and issues that you haven't been able to get, yet, or ever? That's a question for any of the panelists.

MR. FRANCO: I think we're starting a process of talking to the utilities. We're going to be working with Kristin on that, you know, to find out how they do planning, and what specific information they need.

And that is also coordinated with another work that we're doing for OPR, for Louise. And we're talking to the different State agencies to find out exactly the

same, what do they use for planning.

Like, for example, for the energy sector we use the one in ten event to -- my understanding to determine if there is enough capacity for the electric system, you know, to be able to cope with very high temperatures.

So, these type of things we're going to be talking to different groups and then to also quantify them in the sense that -- I mean, we're using the climate scenarios to see how those thematics will change with time.

With respect to information, I mean so far the utilities have been extremely helpful. But we also note that there is a CPUC order mandating the assistance from the utilities to research groups, you know, for that information for the studies. We understand that there is a need to keep confidence -- information confidential. But I think the order covers all the aspects of how to do that.

MS. HALBERSTADT: I think, also, the database that I mentioned, the AB 2516 Sea Level Rise Planning Database, could be a helpful tool here because we've already surveyed several utilities to find out what types of steps they're taking to address sea level rise. And we have a range of answers and a range of steps. You know, everything from we're not really doing

anything because we don't think we're going to be affected by it, to very sophisticated, detailed analyses.

So, I think that work that we've collected could help significantly with the CEC and CUPC work.

MS. RALFF-DOUGLAS: And I would add that the resilience plans that will follow the vulnerability assessments are really a scenario planning opportunity for the utilities to tell us how they're planning, and how they're going to address each one of these vulnerabilities from a systematic perspective and a long-term perspective. So, kind of an iterative process on that, as well.

DR. EWING: And then, as with the Coastal Commission, we look at the repowering projects, I think it would help to understand the full complement of components that are part of that repowering, so that we're seeing sort of the full package, rather than upgrading the distribution lines, transmission lines in year five, and then doing the power plant in year seven. Tying -- what ties things into the decision process and where are those key steps so that we're helping guide that in a way that's beneficial to everyone.

MR. ALEX: So, thank you very much for the presentations. I think one of the most difficult issues

and sets of issues is around costs and financing. It's probably premature to -- you know, there will be all kinds of different strategies. But I just want to make sure that it's part of what you're thinking about as each of your agencies moves forward in this process. I think we all have a pretty big challenge with that. So, pretty much a comment and feel free to respond or not.

MS. RALFF-DOUGLAS: One of the things that we asked the utilities to do, when they come up with their resilience plans, is to look past just the cost benefit analysis, which is a very useful tool, but a somewhat limited tool to decide between one action and another.

And we're asking them to start thinking about it on a much broader framework of decision making. Of when do you take an action? What kind of action do you take? What are the opportunities and what are all the costs and the benefits associated with that? So, it's a much broader way of looking at what those costs would be.

MS. RAITT: So, Commissioner, I just wanted to let you know we've come to the end of the time for this panel that we've allotted.

COMMISSIONER DOUGLAS: I think we may have one more question or --

MR. BARKER: I was just going to make a comment. Looking at the title of the workshop, that it's Climate

Adaptation and Resiliency. And so, touching on Tina's presentation about looking at resiliency, and potentially the cumulative impacts of climate change, plus these other issues of energy security with regards to either cyber issues or physical terrorism.

I guess when I look back at the last few years, I feel like California's sort of been the Guinea Pig for resiliency. When we had a transmission system built around a huge core piece of infrastructure that, you know, without any foresight goes offline and we have to kind of deal with it.

And then, you know, just last year we had something similar. Not in the electricity side, but on the gas side. And also, a few years ago having, you know, having a physical terrorist attack on one of our subs, which without a -- having the experience of flex alerts probably could have seen a good chunk of the Bay Area, the electricity go down.

And so, just seeing, I guess understanding how to build in the pancake, the cumulative effects of climate, but then also these other things is pretty important and, I think, a daunting task.

COMMISSIONER DOUGLAS: That was a good point, Kevin, and it makes me think back to some of Tina's comments, as well, that resiliency in our system helps

us for a large number of stressors that our system may face, and that we -- the utilities, for example, and the ISO are required to plan for.

And one of those sets of stressors comes from climate change, but there are many others that we face with or without climate change, and face every day, or at least have the potential to. And that's why there is already a lot of ongoing planning and, you know, safety margins and so on built in, and programs built in for that.

And we've certainly, as you point out, have been and are being tested on that front. So, thank you.

So, I think with that we're ready to move on to the next panel.

MS. RAITT: Great. Thank you very much to all the panelists.

COMMISSIONER DOUGLAS: Thank you. Thanks to everyone on this panel.

MS. RAITT: So, our next panel is Examples of Available Tools for Climate Vulnerability Assessment of the Energy Sector.

And our first speaker is Dr. Susan Fischer Wilhelm, from the Energy Commission.

DR. FISCHER WILHELM: Good morning. I'm Susan Wilhelm and I manage the Energy Commission's contracts

that are currently enhancing Cal-Adapt.

Today, I'm going to talk about some of the enhancements. We've seen quite a few enhancements over the past six to nine months and we are continuing to roll them out this summer.

But before I tell you about the purpose of our enhancements and give you a brief tour of what we've done, I'd like to remind you of what Cal-Adapt is. And this is the Cal-Adapt 2.0 that I'll be talking about today. This is the landing page. It's being rolled out at this site.

Cal-Adapt was originally launched in 2011 by then Governor Schwarzenegger. And the intention was to offer people visualizations of climate related risks based on peer-reviewed science.

We aim to provide very easy to understand visualizations, with a primary emphasis on energy sector planners, operators and managers. People who need to use climate science to support their decisions, but they're not climate scientists.

We also offer access to primary climate change data for those who seek to perform additional analyses based on the data visualized at Cal-Adapt. And we complement other tools, such as Climate Console and CoSMoS, which we'll hear about later. The federal

effort to develop a climate resilience toolkit.

And, in particular, I'd like to say, regarding Climate Console, that whereas the folks at Conservation Biology Institute have developed a tool tailored to support analysis involving ecological conservation and protection, Cal-Adapt has evolved more with a focus on man-made infrastructure, as you'll see a bit later on.

So, the goals of recent and ongoing enhancements with Cal-Adapt are first to provide higher resolution, regionally down-scaled data that align with the Intergovernmental Panel on Climate Change, the IPPC's latest assessment report. And also to provide higher fidelity data portraying wildfire, the impacts of sea level rise and hydrological changes.

We're also working with Cal-Adapt 2.0 to help users understand how to use climate change projections and how to interpret their visuals. And Cal-Adapt 2.0 is built around an API, or an applications programming interface, that supports third-party tool development and also opens a host of opportunities related to interoperability with other tools.

Finally, a key goal of the enhancements that we're working on is to be responsive to utility resilience needs in the energy sector.

To that end, we have assembled a Technical

Advisory Committee that contains representation from all of California's Investor Owned Utilities, from a Publicly Owned Utility, as well as the California Independent System Operator, and several of our sister state agencies and offices. Namely, the Department of Water Resources, the California Office of Emergency Services, the Public Utilities Commission and the Governor's Office of Planning and Research.

Okay, so let's now turn to have a look at the tools that are available right now on Cal-Adapt 2.0. I'm going to step into the annual averages tool, which offers a look at daily maximum, daily minimum and daily precipitation.

So you see here, with Cal-Adapt 2.0, that in addition to looking at climate projects, you have observed historical data from 1950, visualized here through 2005. You can see the envelope of modeled variability associated with IPCC's suite of fifth assessment report climate models. And you can see climate change projections for a particular scenario based on these ten global climate models.

And just a note regarding these particular ten models. These are those that Department of Water Resources has given the -- I don't want to call it their seal of approval, but has pointed to as here are some

models that provide adequate representation of some processes key to water resource management in California.

Regarding our attempt to provide plain English interpretation, if you go to Cal-Adapt 2.0 you will find a very clear description of what you're looking at, and a very clear description of the two IPPC scenarios that are available. Presently, RPC 4.5 and 8.5. And you also have a slider so that you can look at multi-decadal averages based on the center point of your interest.

If you don't want to look at all GCMs, all ten climate models that we have up there, you can select those that you prefer. And here you see selection of the four models that Dan Cayan will speak about this afternoon.

Another key element of Cal-Adapt is that we're working to support California's fourth climate change assessment by serving key datasets. Namely, as Guido spoke about earlier, a consistent set of peer-reviewed, regionally downscaled climate projections. And this is super important to facilitate cross-study integration across the whole suite of fourth assessment studies.

We also serve historical data. And your handout may say through 2005, but in fact the observed historical dataset runs through 2013.

And we are working with UCLA to link to their dynamically downscaled data, which you will also hear about this afternoon.

These datasets are available through a super easy-to-use download tool. Users can select their spatial and temporal extent. They can download things as geo TIF files or, in response to our Technical Advisory Committee, we're also providing for tabular downloads.

Several datasets are coming soon. We are working on visualizing snowpack. We're working with Department of Water Resources and other water-concerned folks, including the utilities, to think about how best to represent stream flow data.

And we also have in production mode, but not yet public, a new sea level rise dataset that portrays for the open coast, as well as the bay and the delta inundation associated with an extreme storm event, plus various increments of sea level rise.

Another enhancement in Cal-Adapt 2.0, that was launched in response to Technical Advisory Committee input, is several new aggregation options. So, in addition to looking at projected climate changes for a grid cell of about three and a half miles by three and a half miles, you might want to look at climate change

associated with a particular watershed, climate zone, with DWR's integrated water management boundaries, of course census tracts, legislative districts.

And what I would like to demonstrate for you today is looking at a particular area, through the lens of climate risk, that you've selected on the basis of its, perhaps, being a disadvantaged community.

Oh, finally, of course, most importantly, also in response to utility sector input, we are supporting upload of user-specified shape files. So, if you have a shape file representing assets of interest, you can upload that and look at climate risks accordingly.

Okay, so suppose we're interested in extreme heat in disadvantaged communities. Here, you're looking at census tracts in Fresno. These census tracts are color coded on the basis of their CalEnviroScreen score. For those of you who aren't familiar with it, CalEnviroScreen was developed to help facilitate preferential investment of greenhouse gas emissions reduction funds in disadvantaged areas.

So here I've selected a census tract with a fairly high score of 75, on a scale of 1 to 100. And you see that for this area in Fresno the project number of extreme heat days in the latter decades of the century has jumped from an historical average of four to

55. This is a high emission scenario and extreme heat days are defined with this particular locale in mind, namely the 98th percentile maximum temperature, which happens to be just shy of 107 degrees.

You can also see for this area of Fresno, and in general in California, that whereas historically the extreme heat season spanned, you know, June through September, moving through the end of the century, on a high emission scenario, we're going to expect to see extreme heat starting in early May and continuing well into October.

The other thing I would point out for this Fresno-oriented graph is that towards the latter half of the century we are seeing hot days in the yellow zone which, on this graph, represents 113 to 131 degrees Fahrenheit.

Okay, so the final dataset, again not publicly available yet on the Cal-Adapt beta site, but in production mode, portrays inundation associated with various increments of sea level rise, plus an extreme storm event. And in addition to modeling the coast and the bay, John Radke's team at UC Berkeley has allowed us to look at the delta.

So, you see here that with 1.4 meters of sea level rise, plus an extreme storm event, both McDonald

and Sherman Islands areas, with important energy infrastructure, experience some flooding as indicated by the blue. And we will be able to view the overlay of the social vulnerability scores by census tracts. But you can see in this lower left-hand graph that there is quite a bit of social vulnerability in these areas, especially associated with San Joaquin Valley.

Thank you and I'll pass on to my colleagues.

MS. RAITT: Thank you, Susan.

The next is Dr. Patrick Barnard from the US Geological Survey.

DR. BARNARD: Thank you. I want to talk about the development of a modeling system to look at the impact of climate change on the California coast. This is something that we've been developing for about eight years or so, now, in a collaboration with Point Blue Conservation Science, who's developed the web tool. Which some of you may have heard of Our Coast Our Future. The CoSMoS, the Coastal Storm Modeling System, is the model itself. The tool, the web tool is Our Coast Our Future.

And a lot of the scientific outreach in Southern California in the last couple of years has been done by USC's Sea Grant.

Now, Pacific Institute really put the scale of

climate change impacts on the California coast on the map, in their study that was completed back in 2009, where they estimated about half a million people and about $100 billion in property are at risk from coastal hazards over the next century.

Recent work, however, also looks at the trend in population growth in California and suggests that perhaps over a million people could be at risk in upper sea level rise scenarios over the next century. Which does not include any estimate of storm impacts. Simple bathtub sea level rise, alone.

But as we know, during El Nino events we see very large impacts. In the last two, very large El Ninos we experienced several billion dollars of impacts along the California coast. And even though this last El Nino didn't see the storm impacts, the beaches were as eroded as they've ever been in the 20 years' of measurements.

So, we're trying to develop a system to look at coastal vulnerability to climate change. There's lots and lots of factors we have to consider. We have to consider global sea level rise. We have to consider regional sea level rise variability due to things like ocean circulation patterns. Glacial fingerprinting, which is basically gravitational changes due to ice

sheet melt, tectonics and isostatic rebound.

So, this is just a map showing about the last 20 years of sea level rise. And you can see it's very heterogeneous, with very high rates of sea level rise in the Western Pacific and very low rates in the Eastern Pacific, which has actually just switched over the last couple years.

But then locally we have to consider subsidence, we have to consider local tectonics, fluvial discharge, sediment supply, development. And L.A. Basin is a great example of highly variable vertical land motion due to subsidence and due to tectonic activity, which also has to be considered.

And then the dynamic water level component, which is where CoSMoS really comes in. Going beyond this bathtub approach, but looking at steric effects. So, when we have an El Nino winter, the water is warmer. We have water levels about a foot higher across the California coast. And then, very short-term effects of waves, storm surge, and also event-based river discharge.

So, just to kind of look at these two different types of approaches, there's a static approach or a bathtub approach that NOAA has developed. Which is a really nice tool, the NOAA sea level rise viewer, for

looking at the daily impacts of sea level rise. And it's done on a national scale. It's a passive model. There's hydrological connectivity, but it's really just looking at these two components of water levels, and that's sea level rise and tides which are about, oh, two meters of variability across California. You know, let's just say a target's of about a meter of sea level rise by 2100.

Now, these are going to under-predict flooding hazards because they don't consider all the dynamic components of water levels on a day-to-day basis.

And that's the system we've tried to develop, known as CoSMoS. We try and model all of the relevant physics that contribute to coastal water levels along the coast, forced by global climate models, and considers all these different contributions to total water levels during day-to-day activity. From simple average waves to extreme 100-year events. So, the seasonal effects, the storm surge, the river discharge and the wave-driven set up and run up along the coast.

So, considering the static approach alone, you may have water variability on the order of about three meters or about ten feet. But during a storm event you can increase water levels on the order of four meters or more, talking 12 to 13 feet. And that's what we're

trying to model so you understand the full scope of potential impacts to your coastal resources.

So, this was developed as the first modeling system for the California coast to look at coastal hazards. We predict hazards for the full range of sea level rise scenarios, up to five meters. So, as guidance changes, we're going to have a scenario that's going to be, hopefully, within that envelope, so we're not going to generate products that are obsolete.

And also, storm possibilities from your daily impacts of waves to your extreme events. So, if you're an emergency responder, there's a scenario for you. If you're looking at a most extreme event out at 2100 or beyond, there's a scenario for you.

So, and these tools have been developed with numerous State and local agencies. And recently, to a great effort to support all the different climate change guidance and vulnerability assessments that have been going on throughout the State.

So, how it basically works is we take the global wind fields from the latest IPCC models. We use that to generate global wave models. And you say, well, why do we have to go to this sort of scale? Well, the California coast is affected by waves from Antarctica to Alaska.

And even though we didn't see the impacts of this last El Nino in terms of local storm impacts, the coast, the beaches were as decimated as they've ever been in the last 20 years or more because we get waves from across the Pacific. They impact our beaches, they impact our vulnerability. Even if we don't have very strong, wind-generated waves locally, we can get very, very large waves that are generated from throughout the Pacific.

Then, we scale down to local hazards projections. And here, we've been using the downscaling work by Dan Cayan and Davie Pierce, developed for the fourth assessment. So, we have locally generated waves and storm surge, as well as these far-field generated waves.

So, this work has been done in the Bay Area and completed, both the CoSMoS modeling, and also the Our Coast Our Future web tool, done in 2013 and 2014.

We're currently extending the work up to Pt. Arena, and with support from the Coastal Conservancy and from the fourth assessment we are on the verge of completing this for Southern California, as well.

And the plan is to move up the Central Coast next year and the North Coast in 2018, so we have a consistent and complete coverage of the entire State of

California within several years, with this robust approach.

So, almost equally important, arguably more important, is how we serve this data up so it's accessible and usable by agencies, in a flexible web interface. This is the Our Coast Our Future tool. Anyone can go in here, log on, play around with it. It's available for the whole Bay Area, now. It will be coming to Southern California in the fall. So, you have a choice of looking at the hazard of your choice, flooding, waves, tidal currents, uncertainty related to coastal flooding. And then, a range of sea level rise scenarios from zero to 5 meters, and storms from daily conditions to your 100-year event. Lots of different shape files and other layers that you can put on there.

But here's an example from Pacific, looking at flooding due to sea level rise alone, around 2100. So, if you have an infrastructure that's sensitive to sort of daily flooding, this is what you might look at.

If you're more sensitive or concerned about the extreme events, then you can turn the storms on and look at the difference between sort of your daily impacts and your extreme event impacts, and plan accordingly.

So, the primary products are flooding. This is just a snapshot from North Bay, looking at the maximum

extent of flooding during a storm, the depth. We also identify areas that are not connected to the bay or the ocean, but would be flooded if a berm broke, or a seawall broke, or a levee broke, so there's not a complete false sense of security. So, those vulnerable areas are designated.

Another, I think equally important product, is uncertainty. All we're showing in that prior map is sort of the bulls eye of the model, but there is uncertainty in the model physics, how they're parameterized, the digital elevation data, the vertical land motion, the behavior or tidal marshes.

And so, here's an example from the San Francisco Airport, looking at flooding with just 25 centimeters of sea level rise in your typical average storm. But if you look at the full range of uncertainty in the model, and all the different components that go into it, this is what we present as a worst case scenario. So, for a very high value infrastructure, like an airport, this is probably the product that you want to be looking at.

Also, flood duration. Is your area during this particular scenario going to be flooded for five minutes or 24 hours, during a storm for example. So, you have some idea of the vulnerability.

Also, waves, in terms of harbor safety and

potential damage to infrastructure. This is looking at a 100-year event in the San Francisco Bay Area, showing you can get waves on the order of 40 feet on the open coast and, actually, some penetration into the San Francisco Bay, as well.

So, lots of different products. And we're always looking for feedback from the agencies about what other products they may be able to use.

For example, Caltrans wanted elevation data for all the flood levels to be presented in a more seamless fashion. Instead of what gets wet, but how high, so they could relate it to their bridges and other infrastructure in the transportation system.

And then the next iteration here, which is in beta form, will be coming out in about a month. And then following this, in concert with the physical impacts, will be the socioeconomic impacts. So, Nate Wood's group, within USGS, is developing the socioeconomic impacts web tool. Which will then translate what are sometimes esoteric flood extents into how many people, how many dollars are at risk?

And a lot of this is census based. There's lots and lots of information that can be gleaned from this data, as well.

So, this is kind of where we are now. Expanding

to Southern California. We released the extreme storm scenarios back in December of 2015, which also included projects of cliff retreat and beach erosion. And this was with five different sea level rise scenarios at the two meters. This is available now online, in KMZ format.

But coming in the fall are all 40 scenarios of sea level rise and storms, flooding, extent depth, duration. And the coastal flood extents are integrated with how the beach and how the coast is actually evolving through time. It's not a static system by any means.

The web tool will be there, the socioeconomic web tool will be there. And then we're going to move on to Central California and beyond.

So, thank you.

MS. RAITT: Thank you very much. So, next is Dr. James Stritholt.

DR. STRITTHOLT: Sorry, I had everything saved prior to the meeting and it just got -- it got deleted, so I'm going to go live, instead of using Power Points.

Here we go. So, this project started -- actually, we did a Climate Console for the Desert Renewable Energy Conservation Plan. It launched about a year and a half ago, I guess.

And because of that, we were asked to try to extend it to include the entire State of California. So, this is now live. Not everything I'm going to show you today is live. The last panel that I'll show you will be live in July. But I'm going to show you some of the basic features of this.

It's really, this particular application is actually an extension of our database and platform. And we were trying to come up with a way that we could allow people to see as much content as possible, and in as user-friendly way that we could think of. And that's what you're going to see.

There are actually over 900 datasets in this. And, hopefully, it wouldn't look like it as you drive the system.

The way it's set up is to be quite simple. You're going to go in, select whatever reporting area you're interested in. So, if you're interested in county boundaries, or eco-regional boundaries, or other jurisdictions this can be added to. These are just the ones that we currently have.

So, you would go in and pick whatever one of these features you wish. You would select the ones you want. You can select one or more of them. Let me just pick Fresno County. And the results appear on the right

banner.

We try to have numerous pop-ups to help people orient of what am I looking at and what does this mean. I'm going to close those just to make this go a little quicker.

And up at the top banner you're going to see several tabs. There's climate, weather, conditions, and impacts, and ecosystem services. And so, there's information under each one of those and they're all map-based.

If we look at the climate tab, the options to look at, and this is pretty typical of any type of climate change adaptation. And I'm going to be moving away from this pretty quickly. But just to give you some quick orientation of the entire site.

It has some of the basic pieces. There's maximum temperature, min temperature, precipitation, aridity, and PET is potential evapo transpiration. How does it affect plants?

Now, as Susan mentioned earlier, this site is really targeting natural systems, although a lot of this has applications of other human infrastructure, as well.

We've used the ten models that have already been discussed, so there's consistency in the models that have been chosen.

The way this is set up, so if we're looking at maximum temperature for this particular county, and we want to look at -- we can look at either metric units, or if you want to be English units, if that's more comfortable, we can look at averages or changes between the years. And we look at either annual or different seasons. Because, depending on what your interests are, you may be interested in what's the spring going to be like or what's the fall going to be like? Particularly, if you're looking at things like fire or other kinds of disturbances.

Every one of these dots on this graph are actually linked to a map. And all of the maps that are in this system, there is a hot link to Data Basin, so if you see something of interest in this particular application, and you now want to add other data to it that you may have, this is your gateway to do that. It's the click, you open up the database in viewer, you can add your data and you're off to the races from there.

And as you can see from this chart, there's pretty much agreement. You can see all the models are pretty tightly packed. And these are -- in this particular graphic, these are 30-year averages, going from 2016 to 2045 is this chart.

But what you're looking at is the models are in high agreement. And so, and that's no big shocker to folks in the room that the temperatures are predicted to continue to increase over time. And there's a quite good fit on model agreement.

However, on precipitation it's less clear. There's greater uncertainty about what's the precipitation story likely to be? And so, you'll see ranges. And the system allows you, this application allows you to try different ones.

What if we're talking about a wet future in the near term? And if I look at the change, it could be close to 19 percent wetter, if it goes that track, or it could be 14 percent drier, even though the temperatures are always pretty clear are going up.

If you want to see a super-simple graphic of what the averages are for all of the models, they're presented down below, showing the relative increases in temperature and either increases or decreases in precipitation, based on an average of all of the models.

The weather tab was set up, this is actually a live NOAA feed. And it looks at temperature and precipitation at three-month rolling averages. And this is more on the short term. One year out type of thing. And we're looking right now and it's saying that it's

going to be warmer than normal. A big shocker, because it's going to be over 100 today, so there's some agreement there.

This is animated. We could either animate the temperatures going forward, so it's going to be quite a bit warmer in the not-too-distant future. The next three or four months are going to be far warmer than normal, according to the NOAA weather centers.

I will stop it. We could do the same for precipitation and see if it's predicted to be wetter, drier or normal over these same time frames.

Why is that important? If you're a manager, it might tell you whether this is a good season to do the restoration you were anticipating doing, or maybe you wait. The weather is not going to be suitable for the financial investment in the field crews that you're going to put out to either do some type of controlled burn, or a restoration, or plantings, or what have you.

There is also a conditions and impacts tab. There's more being added now. Those of you who are familiar with our intactness model for the Desert Renewable Energy Conservation Plan, we have one now for the entire State of California. It will be loaded in this, in the next couple of weeks, and it will be located here.

This particular part of the model is looking at site sensitivity. This is largely based on soil characteristics, depth of soil, amount of water in the soil, and so on. And this model that's used to generate this map that you're seeing is all transparent down below, and you can unpack each piece to determine where in this region, and why is it mapped and indicated as it is.

The last tab that I want to show today is new. And there's a whole lot going on here, so I'm going to take just a moment to explain it. It's still being quality controlled and it's going to be out in July. But you're getting to see a sneak peek.

I selected -- this is by -- right now, it's only by watershed. We're going to have all of the other reporting units on the left margin, like you saw in the other graphic. And this time we're actually taking it one more step. Rather than just looking at what the temperature and precip is doing, we're trying to anticipate what the effect on the vegetation is going to be.

And we built in current land use and land use projections, from Ben Sleater's lab, with USGS, up in Tacoma, Washington. So, you're going to see agricultural land embedded here, as well as urban land

embedded here, as we move into the next 100 years. And I'm going to do it decadally.

The area that I selected is just this watershed here. It's near the Kings River area. And it's along the Southern Sierra Nevada. I could choose any of these watersheds, but I'll just do this one because of the sake of time.

And I'm going to actually run the animation. It's just going to take a few seconds to run. These are decadal averages. And I'm going to let it run again. And there are a couple things worth mentioning.

So, for this particular watershed, you can see what the profiles are going to be. There's going to be -- according to the climate variables, there is likely to be a decline of conifer cover and increased in mixed forest for that particular watershed. I will stop it.

The other thing you're going to see, as this animates, you'll see the light green moving upslope in the Sierra Nevada. That's the mixed forest moving upslope as the conifers receded and the actual, the taiga tundra are reduced, as well.

The other thing you're going to notice, probably the most obvious thing as this is moving in front of you, is this yellow and red flashing in the desert. And

so, that's based -- the yellow is grasslands and the red is desert, and the brown is more of a shrub land type pieces. The deserts tend to be flashing naturally. And this is what -- these are based on decadal averages of the projection models.

As things get wetter, you'll see the flashing of the yellow. As things dry down, they'll get red and brown.

That has lots of implications for this particular region. In fact, if I were to pick a watershed down in this geography, I'll pick this one, you'll see pulses. And you can pick one of four models. Do you want a warm/dry future? Do you want a hot/dry future? Do you want a warm/wet future? To make it as simple as possible to try to understand what are the likely vegetation responses going to be.

We've also graphed a number of other services down below. We've got amount of dead biomass. We've got total ecosystem carbon. There are other, stream flow, climate water deficit. These are all graphed for you, for each place that you select.

Climate water deficit is plant stress. And so, what this doesn't do is it doesn't really show, explicitly, the extreme events. It's really hard to do extreme events. But if we looked at this region just

right now, if you look at is there a likelihood of more grasses there? Yes. And with the grasses come fire.

In fact, there is a -- we just finished a study on the last 40 years of fire in the DRECP. And over the last 40 years there's been a quite a bit of increase in the number of fires and the number of large fires. And they focus in on this geography right here, where all the yellow is popping up. So, that may become more reinforced. And it's largely driven by exotic grasses.

So, I'll end with, so that the applications of these sorts of things are varied. In the case of the fire grass, it would be to make sure that the invasives cannot get a toehold, and you have a very narrow window of controlling them. Once they reach a certain coverage, it's going to be very difficult and very expensive to stop it, and it's going to transition into that sort of system that, traditionally, had not burned in the last several hundred or even thousands of years.

So, with that, I'll stop. I think I'm out of time because you're standing and I'm feeling the footsteps. So, thanks.

MS. RAITT: Thank you very much.

Are there any questions?

MR. ALEX: I have a question. First of all, all three of these are very impressive and, you know, thank

you for all your work on it.

As I sit here and watch, I mean this is a question as much for us, as you. But I'm -- it's persuasive in a lot of ways and I don't think we've been very good at getting this type of information and really, nicely presented to the public.

And I'm wondering if you have any thoughts about how we might do that with some of the tools that you've helped create?

DR. FISCHER WILHELM: For Cal-Adapt, currently it's supported by two funding streams, the EPIC and the Natural Gas PIER funds. Both of those contracts have, in addition to getting input from energy sector stakeholders on what they need, developing training modules so that we can help them -- what do you need? What tools can we build for you? And how can we help you understand how to use this? So, we are working on that for the energy sector and would love support beyond the energy sector, for sister agencies.

DR. STRITTHOLT: For the Climate Console, we just completed a pretty extensive one-on-one set of surveys, with a large -- a variety of different folks. And one of the things that came out of that was the need for use case examples. To walk someone through. If I'm this type of person and I'm responsible for this, to

take these sorts of actions, what do I do? Give me an example or two that I can begin to relate. And then, they tend to have a much quicker absorption time, and then they get it.

And it's interesting that over the years what we've seen is when you do that, people get real creative really fast. If you don't do that, they tend to look at it and go, wow, this is really pretty but I have no idea what it says, and I've got to go do my job, now.

And so, that's kind of an important thing that we need to follow up on and try to identify use cases that are identifiable to different sectors.

DR. BARNARD: Yeah, I think for us, you know, the sciences are starting to realize that the presentation of science is just as important as the science, itself. And so, when we got involved in Our Coast Our Future Project in the Bay Area, and working with Point Blue, who are experienced in the scientific outreach, it really opened our eyes to how critical an element that is in any scientific endeavor. Especially, when it's going to, hopefully, serve the public good.

And so, there was a lot of work on the front end, throughout the course of the project, on the back end, and beta testing the tool, dozens of meetings, webinars. And the same is going on in Southern

California, now. We found it critical to have people on the ground, like USCC grant, who's deeply invested and intertwined in local politics throughout the region. So, they know who to reach, who to talk to, who to ask for advice, who to get feedback from so that we're developing a tool on the back end that's actually going to be usable by these agencies who need information to do their job.

So, it's the outreach component has much more emphasis and it's currently funded through the fourth assessment, now, for Our Coast Our Future for Southern California.

MR. ALEX: Thank you for that. I think we'll probably want to spend some time thinking about how these tools may be able to reflect future scenarios, maybe even district by district for Legislators and local governments.

MS. RAITT: Commissioner, I wanted to just let you know we have come to the closing time for this session, if you wanted to.

COMMISSIONER DOUGLAS: Thank you, Heather, for keeping all of us on track.

(Laughter)

COMMISSIONER DOUGLAS: Let me see if there are any other questions from the dais.

I don't think I have any questions. I want to just also join Ken's statement that these tools are really impressive. And you can see the amount of work and science, but also thought as to how the science will be used that has gone into them. And, you know, we need this kind of focus and these kinds of tools to really be able to meet the promise of taking climate science and making it actionable in the adaptation realm.

And also, as we consider the many different decisions that we all have to make that really, and to some degree or another, interact with or take place within the natural environment that is being effected. And that would be most of our decisions, if not all of them, at some level.

So, this is very helpful and I appreciate all of your work. Thank you for being here today.

And it looks like we are going to lunch about four minutes late. And we will try to restart on time. So, thank you.

MS. RAITT: And I just wanted to note that we do have three papers out by the entrance that weren't out there this morning. They're on a separate table. Two papers by Scripps and one by UCLA that pertain to this afternoon, if you'd like to pick them up.

(Off the record at 11:55 a.m.)

(On the record at 12:53 p.m.)

MS. RAITT: Okay, so welcome back. We'll go ahead and get started, again. The Agency IEPR Workshop on Climate Adaptation and Resiliency for the Energy Sector.

And this afternoon, our first panel is on Selecting Climate Scenarios for the Energy System. And the Moderator is Guido Franco. And go ahead. Just a minute. Okay, my mistake. I'm very sorry for the delay. We are ready, now. We will be ready.

MR. FRANCO: Okay, thank you, Heather. This is Guido Franco from the Energy Commission.

So, this session is about climate and sea level rise scenarios. So, before Dan and Katharine give their presentations, I just want to say a few things. First of all, as you all may know, California has been a leader on climate scenarios work for a long time. And the work that California has been supporting in the last three years, or more, has also brings us to be a leader, again, to developing climate and sea level rise scenarios.

Climate and sea level rise scenarios are being used in the Energy Commission for multiple purposes. For example, in the IEPR, the Integrated Energy Policy Report, there is also a demand forecast that already

considers climate change.

Also for planning purposes, for example the DRECP, the Desert Renewable Energy Conservation Plan. You know, there were some studies that included considerations of climate change.

Yeah, so the -- okay, so we have, in the last three years -- I mean, three years ago we commissioned a study by Scripps Institution of Oceanography to develop a new downscale methodology. Because we knew that prior methodologies that we were using to translate the outputs of global climate models to the California region, that they had some issues.

So, Dan and his group, Dan Cayan and his group has been able to develop, I believe, one of the best methods to translate the outputs of the climate models, the global climate models to look at regions.

And the methodology has been adopted by the U.S. Bureau of Reclamation, by the Army Corps of Engineers, USGS, and so we're looking now to have the same method as being used on a national scale.

That benefits what California is going to be doing for climate impacts and adaptation studies because we can also look at the studies that are going to be done outside California and look at implications of the climate scenarios of impacts outside California to what

may happen in California.

Also, we're lucky that UCLA has received funding from Department of Energy, the National Science Foundation, and the Foundation, you know, to develop a new methodology to use a numerical model, to also develop climate scenarios for California.

So, the first talk is about climate scenarios for California. Dan will give the talk. And then he also -- he will follow that by talking about new estimations of sea level rise for California.

MR. CAYAN: Thanks, Guido. And good afternoon, thanks for inviting us.

I'm standing in for David Pierce, who's really the engineer of the methodology that Guido just mentioned. We're dividing and conquering amongst the group here.

So, what I'm going to lay out, in very brief detail, is a set of climate scenarios that we're going to use in the fourth assessment, and some of the objections, and so forth in the development that Guido mentioned.

And then, I'm going to follow this with the discussion of the sea level rise scenarios which are, to some extent, coupled to the so-called climate scenarios that we're going to talk about here.

So, as you all know, the IPCC enterprise has produced a number of global climate simulations internationally that's been collected in a dataset that's called CMIP5. That actually is our archived over in Livermore, amongst other locations.

But there are, nowadays, really scores of those climate simulations that are available. When we were undertook this project there were a little more than 30 of those GCMs, and we've included 32 climate models that had daily resolution and had a commonality of greenhouse gas emission scenarios.

In this generation, we're referring to the RCPs, representative concentration pathways, 4.5, 8.5 being kind of mid and upper level RCPs. Those are laid out in the figure here, where this is actual emissions. As we move through the 21st Century, under the upper lower.

And also, as will come out in the sea level rise discussion, there's some aspirational scenarios based on nationally agreed upon, at least verbally, commitments, which will be interesting to see if those actually play out as far as global reductions.

But as you can see, I think a point to be made here is that the actual emissions, which are shown by the black dots, are lying pretty much on top of the higher greenhouse gas scenario.

So, in developing the scenarios for the fourth assessment and, in fact, for the downscaling problem, in that we have a very textured landscape in California, with a lot of gradients and so forth, global models are often calculated on -- over tiles that spatial horizontal scales of, typically, 150 kilometers. Which, of course, is much coarser than is useful for a lot of the decision making problems that we have. So, downscaling is really key.

The other issue that we've addressed in these scenarios is that models have usually offsets from the real climate, so-called biases. And not that this is a different form of the word "bias" than is used in social science lingo.

But we have a so-called bias correction routine that has been newly developed, which is part of the package in developing the scenarios for California. So, by so doing, we have adjusted the models to conform more to reality than they would if you used them in the raw form. And then that translates on into the downscaled form of the solutions.

As I mentioned, the global models are often, almost invariably too course. So, in this effort that Guido mentioned in his prelude, we're actually achieving a downscaling to 1/16th of a degree. That's about 6

kilometers, about 4 miles on a side. Which, of course, is still a little bit course, but it's much better than, say, five years ago the state of the art was more like 10 kilometers. So, we're getting to the scale that's really more in tune with topographic features in California.

And, of course, that's dictated pretty much by observational data. We need to have an observational record in order to achieve a realistic downscaling.

Our downscaling technique, called LOCA, Locally Constructed Analogs, is a statistical technique which uses statistics rather than the form of the downscaling that you're going to hear about from Katharine, that's done at UCLA, which is a dynamical methodology.

The advantage to statistical techniques is that they're computationally efficient and they can be built to be as close as you want to observational records. So, there's a reason for this.

The other problem that we are addressing is that land surface models within climate models vary quite a lot. And so, we're actually calculating, offline, a hydrological solution to a selected set of the downscaled climate models in order to look at runoff, snow, soil moisture, and other hydrologically important measures. And that work is ongoing.

For many users, 32 GCMs is just way too much and there's actually 32 GCMs by, in this case, two emission scenarios, meaning there's 64 simulations. It was already mentioned that through the Department of Water Resources we have arrived at 10 GCMs from this cohort of the CMIP5 simulations, that seem to be best suited for California usage. That's based on the historical performance of the models.

And we have, upon getting some feedback from the State agencies, there was a need for even a smaller subset of GCMs. And so, there's a methodology that's been implemented, that Dave carried out, that derives 4 GCMs. In brief, a warm, dry model, a cooler, still warming of course, wetter model. An average model, if you like, out of the swarm of GCMs. And you saw some of that when Susan showed the Cal-Adapt simulations earlier, just before lunch. And then, finally, what we call a coverage model, which is statistically as unlike all of these other three models as you can derive. So that we're kind of covering the bases of the ensemble of simulations as we move into the future.

Our take on what models we would use for these subsets of GCMs was based on the earlier part of the 21st Century, 2015 through 2050. So, we did not, in that derivation, we did not focus on the end of the

century.

So, that's a very brief run down on the GCMs. And should I just launch ahead to sea level rise? So, I think my technical adviser is going to get me to the next presentation.

So, this discussion is oriented towards a set, ultimately a set of sea level rise scenarios that can be used for assessment of coastal issues in California. And you've heard two or three talks that led up to this, that described a lot of the incentives to look at sea level rise scenarios, by Patrick, and by Lesley, and other presenters earlier. Deborah, for example.

What I'm going to show here is how we're grappling with really an exploding set of new scientific findings that is being included for the California assessment. I'll come back to this slide in a second.

We actually, in guiding this effort, we enlisted the help of a number of peers, which constituted an expert committee. So, there were eight colleagues that we arm-twisted to do pro bono, I might add, to provide a discussion for a proposed framework in deriving scenarios.

And the -- I think I will gloss over a lot of the details. But the essence of the methodology which was more or less endorsed by the experts was, first,

that we would actually use information from the latest GCMs to underpin these scenarios. And, importantly, we actually have strands of scenarios based on different emissions pathways.

So, one of the key elements here is that we really don't know how to blend probabilities of different emissions pathways. So, I can't tell you the likelihood of being on an RCP 4.5 pathway through the 21st Century versus RCP 8.5, or one of the newer, perhaps internationally agreed upon, emission reductions scenarios. So, we've treated those separately.

Another key point is that we will build these scenarios from the bottom up. That is we are, instead of dealing with bulk sea level rise from a global context, we're going to construct these scenarios from the individual contributions from the major sources of sea level rise. Those being thermal expansion of the ocean waters, melting glaciers and ice caps, changes in land water storage by way of either sequestration of water behind dams, or releasing water that's been harbored below ground as we're pumping groundwater.

And then, finally, major contributions over time from the ice sheets in Antarctica and Greenland.

And this was already mentioned earlier that there are some very recent ice sheet modeling results

that actually turn on, at the higher rates of emission, the mass loss of ice and, thereby water, into the global oceans from Antarctica. Which actually pushes the upper end of sea level rise scenarios above what previously, as recently as just a couple of years ago, was really thought to be the maximum possible in the centennial, that is a 100-year time scale.

Also, another element of the strategy here is that we're going to be using a probabilistic framework. It's really quasi-probabilistic based on a number of forms of estimates of probabilities. So, I could go around and sample each one of you and ask what's the likelihood of the stock market changing by X amount. And I could form a distribution of our combined wisdom for a stock market projection.

Well, the same thing has been done for sea level rise in certain quarters. And then, there's other forms of probabilities that can be based upon the ensemble of GCMs, for example, and so forth. So, there's a number of ways of getting at this, so this is very much a hybrid construct that we're getting to.

And then, finally, we are going to translate, using these global projections, to the regional scale, and using some other forms of information from observations, we're going to construct an hourly

projection of sea level rise along the California coast, at locations where we have a historical record with multi-decades of coverages.

So, Guido, I'm going to zoom through these and then you can be shut of me.

So here is, component-by-component, thermal expansion, glaciers, Greenland, Antarctica, and land sources, estimates of contributions to global sea level rise by the year 2100. And each one of these colored bars is a different source of sea level rise estimate from the scientific literature.

The one that is currently being used in California is the NRC estimate, and that's this one right here, this black one. So, you can kind of put -- and the so-called committee estimate for NRC is the center dot for each one of these components.

More or less, the components pretty much fall into a pretty consistent cluster when we look across the realm of them, except for this very recent evidence from Antarctica, which is that kind of outlier bar. And by the way, the bars represent the 5th to the 95th percentile estimate for that contribution.

Of course, again, there's a lot of uncertainty here, for various reasons, which we don't have time to discuss here. Just to aid your kind of calibration,

this dashed line right here is one meter of sea level rise. And again, this is all based upon 2100. And, of course, to achieve the total sea level rise, you would add together each one of these components to derive a total for the globe.

And by the way, global sea level rise, historically, has mirrored over the long term sea level rise along the California coast. So, the global measure is not a bad one in terms of informing us what we are probably facing over the long term. That doesn't mean that we won't have El Ninos, and Pacific decadal isolations and so forth that are going to complexify a bit, and add variability. But over the long term, that's probably what we're looking.

So here are three different emission scenarios. Black, a very friendly one, RCP 2.6. Green, mid-range, 4.5. And blue, 8.5. The whiskers here, again, are 5, 95 percentile. The dot at the very upper end of these charts is the 99.9th percentile. Take that with a grain of salt. But think of that as, under these scenarios, what models, various forms of models would think would be the maximum possible. Again, this is the total sea level rise.

And thanks to Robert Kopp, one of our experts from Rutgers University, for actually carrying out these

computations.

So, as you see, this chart, if I can get the curser to point -- let me just point at the screen. It starts not too far from today and goes through --

COMMISSIONER DOUGLAS: You need to be speaking into the microphone for the transcript. Thanks.

MR. CAYAN: Oh, okay, I got busted. Okay, so here it is. We are going from very near term to 2100 here, and you see how very much emission-dependent is our future in terms of sea level rise, especially when you get beyond mid-century. So, by the middle part of the century, the cumulative amount of warming that is occurring from greenhouse gas loading in the atmosphere really takes hold and the more -- the more fossil fuel-intensive greenhouse gas emissions result in much larger amounts of sea level rise.

Here's a meter of sea level rise, again, to acquaint you with what the center of distribution for NRC was. It is about right here, about 9/10ths of a meter for California.

So, you can see that we are, with the increased possibility of uncontrolled ice loss from Antarctica, particularly the western part of Antarctica, we are being propelled into the very higher amounts of sea level rise, with maximum possible reaching almost three

meters of sea level rise.

Now that, again, is the very outside edge of that envelope and that's -- we were warned about that in a talk earlier, about how we should be paying attention to that. You could debate about how important it is to be paying attention to the very upper part of the distribution. But there it is, under this estimate.

Looking farther out into the future, with a scale change here, now. So, this goes up to 12 meters here on this scale. And this is 2200. We see how the models are actually showing how sea level rise in the long term is really a phenomena that will have to be contended with, even at the lower emissions pathways. This lowest one is RCP 2.6, by the way.

We have charted these percentile estimates for the different emissions scenarios, as well as NRC, in this particular panel. And just very briefly, we have a methodology wherein we have been able to develop hourly scenarios for sea level rise. In this case, this is based on -- this is kind of an old picture. This is based on the NRC Committee estimate.

This is San Francisco. And you can look at, in this case, of course, extremes of sea level that would rise above a given threshold. Which, in the case of the red line, that's one out of every 14 -- one hour out of

every 14 months, historically. Which of course, in the second half of the century becomes quite commonplace.

So, clearly, the message about adaptation needs to be taken really seriously under, really, most of these scenarios.

So, there you go.

MS. RAITT: Thank you very much.

Next is Katharine Reich, from the UCLA Institute of Environment and Sustainability.

MS. REICH: All right. I'm not sure if you can see me over the monitor. I should have worn heels. Thank you for having me.

Alex Hall, whose work I'm representing today, sends his regrets that he couldn't be here. He's at a scientific meeting in the UK. So, you'll have to put up with me.

And I'm going to give my usual I'm-not-a-scientist disclaimer. I handle science, communication and education within the group. So, I have not conducted this research myself. But I'm going to give a very high level summary of the climate scenarios that we've created. And, hopefully, I'll be able to answer your questions about it. If they're very technical, I might have to go back to my team and get answers later.

So, just a little background on what we were

doing when we created these data, these climate scenarios. They were created as part of a project on future climate change, with a special focus on the Sierra Nevada.

As Guido mentioned, we got external funding from this project, from the Metabolic Studio, in partnership with the Annenberg Foundation. And we also had supplemental funding from the Department of Energy and the National Science Foundation.

And in this project the team -- I'll use the royal "we", even though I didn't actually do this myself. We downscaled information from global climate models to bring the information from very low resolution to much higher resolution.

And Dan did a really nice job of giving you an overview of what downscaling is and what the resolution issues are in the global climate models. But I'm going to spend just a second to help you visualize this resolution issue.

So, this visualization is from a similar project we did for the L.A. Region a couple of years ago. And this is a zoom of the greater L.A. area, with the resolution of a pretty high resolution global climate model just layered over it.

So, what global climate model output is, is it's

outputted on a grid cell level. So, each of these grid cells would have one value, say, for temperature, or precipitation, or whatever the climate variable that we're interested in for each particular time stamp we're running the model at.

So, if you look at the example of -- I'll point to this grid cell with Palmdale in it. You can see here that this grid cell represents an area of very high mountains and also of desert. So, one temperature value for this region doesn't make sense. It probably wouldn't represent the temperature in either place. So, that's why we want to downscale to get a more realistic picture of present climate, future climate.

So, this is a zoom in of the L.A. Region with our grid resolution from our L.A. project applied. In this example, we have a 2 kilometer grid resolution. So, this just gives you a sense of now we're beginning to resolve the topography and we can actually represent climate in a realistic way.

So, as Dan summarized, there are two basic techniques that climate scientists can use to downscale global climate model data. There's dynamical downscaling and there's statistical downscaling.

And dynamical downscaling involves actually running output through a regional climate model that is

constructed like a GCM, a global climate model, but is constructed to represent really fine -- or smaller areas at a really fine spatial scale.

So, our methodology actually combines both of these technique types. We do dynamical downscaling with a smaller set of global climate models and then we do statistical downscaling. We build a statistical model that mimics the dynamical model, essentially. We use the dynamical model output to create a new statistical model.

So, our statistical model is a little bit different than the methodology that Dan Cayan's group uses. And since we already have, for the California Climate Assessment, Dan Cayan's statistical output, we're just offering the dynamical downscaling for California's fourth climate change assessment.

So, here I'm just showing the geographical extent of the data that we've created. So, we ran, really, three sets of simulations. One pretty coarse simulation. That's the Domain 1. A higher resolution domain that covers all of California. And then we -- that's at 9 kilometer resolution.

And then we zoomed in on the Sierra Nevada Region and went a little higher resolution. We have a 3-kilometer grid scale there.

So, all of this data would be available to the fourth assessment effort. I think that, of particular interest, will be the California-wide domain at 9 kilometers.

All right, so just to outline what the different datasets are, the first one is a simulation of what we call our baseline simulation of historical climate from 1981 to 2014. And we created that using a regional climate model called the Weather Research and Forecasting Model. And we forced that with, of course, resolution data from the North American Regional Reanalysis.

And then for future simulations, we covered the period of 2091 to 2101, those water years. And we have one representing each of the five GCMs that we dynamically downscaled.

So, to create the future simulations, we looked at the climate change signal between our historical period and our future period in each GCM, and we used that to perturb or adjust the historical North American Regional Reanalysis data. And we used that perturbed data to force the regional climate model.

So, the advantage of that method is that our future period is essentially what would the historical period have looked like if climate had warmed the amount

it's expected to warm by the end of the century.

So, what we're doing is we're taking out natural variability in the GMC climate simulations and we're just focusing on the climate change. The only difference between our baseline period and our future period is what you would see from climate change, itself.

And Dan went over the different representative concentration pathways, the different greenhouse gas concentration scenarios that were used in the IPCC's latest assessment report. And I just wanted to point out that our future dynamical simulations represent the RCP 8.5 scenario, which we call business as usual.

And just a few words about how we selected the five global climate models that we -- that we downscaled dynamically. So, what's on this plot is a scatter. We looked at the change in temperature along the bottom access and the change of precipitation along the Y access. And all of the dots represent a different global climate model in the 32 global climate models, the CMIP5 latest generation GCM ensemble.

So, the ones that we selected span the space, the uncertainty space in temperature and precipitation change. And we did this because we were trying to build a statistical model that would mimic the dynamical

model, so we were trying to sample all the different possibilities.

So, one of our models is a hotter, drier model. Another is a hotter, wetter model. Another one is a little less hot, but wetter. Less hot and drier. And then there's one that's very close to the ensemble mean and the ensemble mean is represented by this star here. So, we kind of spanned the uncertainty space and used those five, the information from those five models, together, to construct our statistical model.

So, this is just a list here, a partial list of the variables that we have in our dynamical model runs, and the temporal resolution at which we have them. So, you know, the statistical data that's available to the fourth assessment has -- I'm not sure which variables you have exactly, Dan, but I think this is going to be a slightly larger set of variables. And so, that might be one advantage depending on what the application is of the research. That some variables might be available here, that are not available in the statistically downscaled data.

And the temporal resolution's pretty high because we were running this model dynamically. So, for surface air temperature we have data points every 30 minutes. For all of the variables it's every six hours

throughout our simulation period.

And that is it. So, if you have any questions, I'm happy to at least try to answer them. Thank you.

MS. RAITT: So, we have a little time for questions of the panel or --

MR. FRANCO: So, I'm the Moderator, but I forgot to prepare questions. So, I'm going to make them up.

So, the first question has to do, and actually, it's a question to the audience, too, but you don't have an opportunity to answer them.

I mean, after the conference of parties in France, Club 21, it seems to me that the world has changed a little bit in the sense that now we have national pledge to reduce greenhouse gas emissions. So, that also complicates the view of what may happen in the future. Some may argue that the RCP 8.5 is no longer -- or, at least, it's not compatible within the INDCs.

At the same time, some people are kind of skeptical that these INDCs, the emission scenarios that are coming from Club 21, that they will actually materialize.

At the same time some countries, like China, they find it is to their own advantage to reduce emissions for reasons other than climate change.

And every five years the countries of the world

are going to be updating their pledges. So, even though this is not about climate scenarios, I would like to hear your thoughts about this, about the future of the global emissions at the global scale.

MR. CAYAN: Well, first of all I think in the short range we are kind of committed to the higher scenarios. That's pretty clear. Hopefully, in the decade beyond range there will be adjustments.

I guess this underscores the need to be looking at a broad set of scenarios.

But I think the other thing to be noted is that even under very restricted emissions we are still committed to climate change. So, there's certainly need for investigation of potential impacts and in very likely adaptation to phenomena such as sea level rise, which has a long time scale that will be probably confronting us.

So, Katharine, do you want to --

MS. REICH: So, I guess I would just piggy back on Dan's point that regardless of the emission scenario that we ultimately follow, and I hope that we follow the scenario that would represent the Paris agreement, that there are lags in the climate system. There are impacts we'll feel by mid-century, at least. But that won't be prevented by that action.

I wish I had the slide with me, I don't. But from our L.A. study, we looked at temperature change across the L.A. Region in the middle of the century and at the end of the century. And we looked at our CP 8.5, the business as usual scenario, and we looked at our CP 2.6, which I think we don't even really look at anymore in the international conversation because it's deemed a little unrealistic, a little too optimistic, now.

And at mid-century there wasn't a huge difference between the two scenarios. In the RCP 2.6 you saw about 70 percent of the warming that you would see under the business as usual scenario.

And where the two scenarios really diverge is at the end of the century, where the RCP 2.6 scenario, the warming kind of levels off and there's no additional warming from the mid-century period.

But under business as usual, warming really continues to rise. So, I think planning for business as usual, as optimistic as I am about the Paris agreement and countries' commitments, I think we still need to understand what business as usual looks like, and what that could entail for us.

MR. FRANCO: Thank you. So, one more question. And this comes to your assertion that from now to 2050 we're almost committed, we're already committed

regardless of the emission pathway. Except for RCP 2.6, but that seems to be too late.

So, for the fourth assessment, we're going to assume that for the next 34 years that it's path independent of the emission scenario. So, I think you would agree that it is a good approach. But still, I want you to say it for the record.

MS. REICH: For the record I think that's a good approach.

MR. CAYAN: Well, I concur. But the other thing I guess maybe should be said is that there's forms of climate -- climate stress that will affect us whether or not we have climate change. And I'm thinking of phenomena such as drought.

And one of the things that I failed to mention in my remarks is the fact that we are, in the next several months, going to be constructing an extended dry scenario for the State. Now, likely that will be piggy backing on top of a temperature regime which is warmer than today. But it would be a mistake if California is not looking at the prospects of a multi-year, if not of a decade plus of dry conditions. We've already seen some symptoms of something like that. And I think that's something we have to prepare for.

MR. FRANCO: So, that's it for this session,

Commissioners.

COMMISSIONER DOUGLAS: Well, thank you.

MR. FRANCO: Any questions?

COMMISSIONER DOUGLAS: I don't think we have any questions. But I really appreciate the presentations and your questions, Guido, thank you. Thanks to all of you and we'll go on to the next panel.

MS. RAITT: So, if the folks in the next panel could go ahead and take seats at the front tables, we have spots for you.

The next panel is on Adaptation Efforts: A Practitioner Panel Discussion.

And we have an opening presentation from Dr. Susanne Moser. And then we have the Moderator is Dr. Louise Bedsworth.

DR. MOSER: Thank you very much. Thank you, Commissioner, for inviting me in. Hello, ladies and gentlemen. For the record, Guido talked to me about communicating path independence for the next 30 years. Let's not talk about it that way.

Anyway, I'll just move right into my presentation. Commissioner, you asked me to frame up the link between the science that we just heard, amazing advances on the scientific side, with what people in utilities, in communities, on the ground in business

have to do.

And the way I want to frame this is through three lenses. One of them is, and this gets into a body of science in the social science arena that looks at what makes the interaction between science and policy and practice effective? What do we know about that? Because I think that will really much frame the guidance that you, in the Commission, will provide, and how to make that link effectively between science and policy.

The second one, which came out really well, I think, in one of the slides Katharine just presented, is this dotted diagram of, you know, models come up with 17 different results on model projections. What does that mean? From a scientific perspective that's fascinating and interesting to reduce that uncertainty. From a practitioner's perspective that's a nightmare. So, how do we deal with that kind of challenge?

And then, finally, how do we actually move that into practical adaptation planning.

So, let me just jump right in here with this. This is, in a way, what I'm showing here how we've thought about science/policy interactions for a very long time. A bunch of research funding goes into the pipe on one end. We're going to do pure research which somehow will magically open up possibilities for

application. We're going to develop that and ready for application. And then somehow, magically, society will gain some benefit from that.

And you can almost see how, you know, this is our setup, right. You had the science presentations first, after a bit of context setting this morning. And now, utilities, go forth and do your thing. And if we're lucky, maybe -- I'm just picking on Cal-Adapt, not intentionally. It could have been the Console, or CoSMoS or anyone. We have these little platforms in between that dish it up a little bit more user friendly. Well, thank you very much, that's helpful.

But is that really the most effective way of interacting? Well, everything we've learned in this body of work on science/policy and practice interaction tells us that's actually not what happens and it never works well.

What happens instead and, you know, this model sort of was based on the assumption that there are a bunch of experts who have the knowledge, and a bunch of other people who don't have knowledge, so let's shove it from one side to the other.

Well, the newer way of thinking is that there's a whole bunch of experts in different arenas. Everyone has another piece of the elephant, basically. And the

point is that we need to get people to interact and talk to each other more effectively.

So, how do we do that? Here is basically what people call transdisciplinary work, so not just working across disciplines, but across academia with people in policy and practice.

And it begins with setting a common vision, setting the research agenda together. By hearing exactly what it is that practitioners need, what do we already know, where are the frontiers of science, defining that together and then developing that knowledge together, seeing how it works when you use that knowledge, evaluating that from all of the different perspectives and feeding that back into the new generation of the next research agenda.

We're moving in that direction here, in California. We're still far too heavily based on the old model of the pipeline.

That new way of thinking about it really has five different elements to it. And I cannot emphasize enough how important it is to pay attention to each one. And it seems to me so far, where we have made progress, is with the joint problem framing.

and in some ways this workshop here, today, and other research agenda-setting exercises have had that

element in it. Basically, both sides contributing to identifying what are the questions we really need answers to.

But co-production goes further. It actually says, you know, you have some data. You can generate some data. Let's do that together and then integrate that into knowledge production.

Co-dissemination, a really interesting thing. So, it's not just the scientists giving the talks, but it's actually the message being carried by translators and by people using it. And saying, here is what we've done together, here is how this helps us.

Checking on how it works to implement it. And I can just say right here, this is a moment that makes many, many scientists highly uncomfortable. To be in the middle of action, of decisions, whoa, not my bailiwick, thank you very much. But this is the challenge to the scientists, right, and to have scientists be in the middle of that. And then evaluating how did that work.

So, there are different phases and different challenges we all have to learn to work together in a new way.

There is a growing body of work on how this is done well and I'm going to just highlight a few items

around this.

So, one thing we have learned is what makes information actually useful? One of them is that it's actually relevant. It's not just, you know, the global projections. It's something that is specific, has high resolution, has linkages across issues. And I want to just say sometimes these go counter each other.

So, all this emphasis in the last five, ten years or so on downscaling -- I love to say downscaling to the small toe is -- you know, we get exactly a picture of what happens right here, in front of my nose. And we forget that we live increasingly in a globally interconnected world.

The Thai floods in 2011, they happened very far away and globally caused a $43 billion impact on industry all over the world, including Silicon Valley. So, it doesn't matter if San Jose only plans for itself, right, or Palo Alto. It needs to know what do my suppliers in faraway places do.

And as the energy sector, you are highly interconnected. Do not only look at what happens, right, to your facilities right there. That would be a mistake.

Credibility. That's another one of the attributes. If the information is not credible or we

don't perceive it as credible, not a good idea.

The process through which it has been created is viewed as legitimate by all parties involved. It actually makes work easier. I can, you know, do something with that. It makes my life not just more complicated and I can easily update that over time.

So, those are just five dimensions of if you don't meet those criteria, it's very likely that all this wonderful science is not going to go anywhere.

Now, I just want to, again, point to an example of what we've heard this morning to elevate sort of the difficult challenges we face, the barriers between having science on the one hand and making good use of it.

I'm going to pick on, just for the sake of example, the Console. Amazing what we can do now, scientifically, in visualizing the dynamic changes in ecosystems.

And the presenter made a comment about it, would you like to have a hot and wet future or a hot and dry future? You can play with that, right, it's like a game.

Well, the rest of you make decisions and you only get one future. One of them. And you don't know which one. So, what are you planning for? You know, so

that really it's like, for the scientists, it's a conceptual challenge that just is amazing to work on and build a career around.

For someone in the practice world, it's like tell me what to do, give me that one target. I think Deborah mentioned this, this morning.

So, there's a very important piece of work we need to do. Not just produce the science through collecting data, modeling it, testing those models, refining them, monitoring how they fare against the real world.

And you, on the practice side, don't just get to plan and invest, and mobilize, and do all the work that you need to do. There's a very important task in the middle. And that's the task we tend to forget again, and again in California.

I just want to -- not only here, but we do forget it here, too. And Cal-Adapt, alone, does not do that. All the CoSMoS in the world will not take care of that. To identify what are the needs of decision maker, to integrate knowledge across different disciplines and understandings. To broker understanding.

This morning we had, you know, this discovery, we need more people to be trained in how to use this model. We could have told you this 20 years ago. I

mean, this is something we understand. People don't use models just because they're out there.

You know, if I gave you a new software to write you text with and you had never used it, how likely are you to take on a completely new software to do what you already know how to do really well with the existing one?

Right, there's a huge hurdle we all have. But we're just giving one more tool, one more tool, one more tool to the next person. That's not enough.

Sometimes just answering the questions that decision makers is not enough. You need to change the environment in which decisions get made. Educate the public so that they can do the -- you know, the right voting, if you will.

Sometimes it's a matter of generating new ideas. You know, we're all used to doing the same thing over and over. But what about generating new solutions. That's a form of being very helpful that we're not spending enough time on.

And more difficult, maybe, might be to be critical and both ways. The practitioner's critical of what the science does and the scientists critical of what politicians or managers do.

So, let me turn to the issue of uncertainty,

which I think is just a really, really challenging one to wrap our brains around.

There's more ways to get from here to the future. What this picture, this comes out as a most recent IPCC showed, is that right now we're in a situation where we already have five physical stressors, social stressors that together sort of bound the space we have to respond to whatever comes. Whether that's a terrorist attack, whether that's the next drought, whether that's the next flood, whatever it is.

Now, we're being asked to essentially bring down those biophysical stressors by radically reducing our emissions. That would be a really great thing to do. And at the same time we're supposed to build up the space that we have to deal with responses.

The good thing is that there is more than one path to get from here to there. But there are decisions you make every few years, however often you change directions in your decisions, that could go one way or the other.

So, the question is, really, how can we always turn, if you will, towards the high resilience, low risk direction?

Now, what I want to say about science, and in particular about scientific uncertainty, is that there

is no knowledge that is inherently valuable to a decision maker, and none that is inherently certain enough.

In the scientific community we've said, for probably the better part of 20, 30 years, that the science is good enough.

Jim Hanson, in 1988, said, you know, let's stop waffling and get on with the business of reducing emissions. That was a long time ago.

So, you know, be that as it may, whether you agreed with him about this, but there is nothing inherent in science that is every enough for a decision maker to move that forward.

And the same is true for uncertainty. But at the same time, every form of knowledge can attain a value in someone's eye, in some context to be good enough and to make it relevant.

Now, how do we do that? In some ways, in the scientific we basically say, well, we put it out there, magic happens and then it somehow gets used in science. Well, under what circumstances? There is actually a science to that magic, what is it?

On the positive side, when someone is personally motivated, I am committed to doing this. I'm going to take this forward. Whatever that science is, is going

to be good enough.

I mean, there are many, many business leaders who have, a long time ago, chose to act on the information. You know, we were less certain then than we are maybe now. We understood less. It was enough for them.

When it's a political motivation. I mean, this is why, you know, in the first Obama administration we couldn't get anywhere because it was viewed as a political risk to take on climate change in view of the next election cycle. So, political motivation was not high enough.

If people see an economic advantage. This is an argument made in this State many, many times. That, you know, acting on climate change, moving into the space of renewables will open up markets and we will all benefit in the State.

That's why a lot of -- you know, Schwarzenegger and everybody else since then basically has moved on that.

There are liabilities, on the other hand, that can also be motivators, maybe negative motivators. And that is if you do not act, maybe your reputation will not be as good. And, you know, in the business, in the market than can matter.

Economic liabilities. You invest money and it's a sunk investment. Not a good idea.

Or, maybe if it's either a political or a legal requirement or by -- you know, I just want to add that to it, possibly a legal liability, where someone could come after you and say, well, you didn't take care of business when you had the chance to.

The more that becomes a legal reality and it is beginning to become that in the global market, the more these things, even if they're scientifically uncertain, will become political certainties.

Now, in that space what do we do? If you will, the space that you have for adaptation is bounded by two conditions. On the one hand, you can imagine that no matter what the climate will do, the impacts will just not be significant for you. It's not something that you need to worry about. I don't know many things, you know, in this sector that will be in that category. But that could be on one end, that you don't have to deal with it.

But on the other hand, no matter what you do adaptation wise, the losses are significant. It's what we do in triage, right? We sort of, in between those things, you figure out what's the patient you can actually make a difference on.

And so, that's really where adaptation promises to make the biggest difference. And then the question arises, so within that what is the scope of what you should undertake? What's the scale? With what urgency should you undertake those? What are the risks and benefits, not of the impact, but of taking the action? And who needs to be involved? How feasible is it to make it happen?

Let me just paint this picture here for you. What it shows here, from the green on the left-hand side to the red on the other is, basically, can you act on these things now versus can you delay?

And so, the greater the uncertainty, the greater far out into the future, the less you can work on it right now.

But what's interesting is, and this is kind of where we have been for many years now, in this country and elsewhere, is that the building of capacity where we do more monitoring, more research, more awareness building, education, training ourselves up that is the capacity building end of things that we have dealt with. And that's really helpful. That is the basis on which we will do a lot more.

But in the short term, there are things you can do that will be good no matter what the climate scenario

will be. And for the long term you can begin to now assess, already, how do we deal with that? How do we solve that problem when it gets there? If it gets there? At least if you start now to think about it, you'll have an answer, as opposed to being behind the eight ball when you get there.

Now, I want to show you how this maybe, might play out in one particular context. What you see here, you've seen now in various ways, several times today, is the San Francisco sea level rise curve. And you see this is the 7 to 8 inches of sea level rise we've seen over the century. And, of course, there are many folks in the scientific community who would say, you know, in the near term what really matters are these El Nino events, because they really give us the sort of most damaging events.

What's interesting is to think about if that sea level rise had not happened, right? So, just pick for example, the last major El Nino, '97-'98, and use that same 13 inches on sea level rise extra, and you just impose that over the sea level from 1900. Well, in Santa Cruz we would say that's a good day of surfing. Right? That's basically if we had not had 7 to 8 inches of sea level rise, it would just be another day at the beach and we would have a good time.

Now, given that we had just 7 to 8 inches, we have had multiple tens of millions of dollars of damage. That's the difference that 7 to 8 inches make.

So, do not tell me it doesn't matter to not think of, you know, the extreme events plus sea level rise. Both of them matter already. Even though you will mostly see it show up in the extreme events right now.

But now we're looking at these kinds of projections. This is from the previous assessment done for California and this is what it looks like. You've seen that. And if you just now divide, maybe, the last century and the coming one, these are the projections. You've heard them, I don't need to repeat them. This is the stuff that we thought it was before. Now, we're obviously considering much higher sea level rise.

Now, just let's divide this into 50-year increments and think about the rise expected in each of these increments. So, it was 3 inches, then 4 inches. The next 50 years is, you know, three times that much. And then, another three to four times that much.

In other words, things are accelerating. What does that mean for our planning? I want to tell you or turn this into maybe a way of framing uncertainty for you in a new way.

Let's just -- here's where we are. This is 2016. And let's just assume you have some energy facility that sits at maybe a half a meter above current sea level rise, right. You basically would say it's safe until it is a half a meter higher.

Well, if we're on this track, on one of the lowest scenarios currently out there, then you have 85 years to figure out a solution. You probably would not spend your day going back to the office, trying to figure that out.

Let's just say we're on one of those higher scenarios, four feet, which is well within the envelope of what California came up with. All of the sudden that shrinks to 40.

I think it was you who earlier asked how long do you need to figure out what to do? That was the question you asked this morning, in your presentation.

So, if it takes -- or somebody else also said it took 25 years to come up with a solution. So, you know, to get the money, to get the permitting, to do the planning, to raise the funds, whatever, to make it then happen on the ground, right. So, we don't have endless amounts of time to make these things happen.

Now, let's assume we're on the highest end of this particular set of projections. Then you have to do

this in 11 years. What are you going to do this afternoon? Right, it's a whole different question depending on where we are on that curve, how much time you have to solve the problem.

That's how I believe scientific uncertainty can become decision relevant. And that is what I think we need to provide in future guidance to people. To say, you know, we don't -- we cannot tell you exactly which one it is, even though I think it's a mistake to think that it is -- you know, that you only have to ask the physical scientists about which is more likely.

We know a lot about institutional pathways. We know a lot about legacies. How fast we can or cannot change people's minds on things, and change institutional practices, market structures and whatnot.

So, there is a lot of reason to believe we're on a higher end of the spectrum. They're not equally likely. So, I think you have less time.

Okay, one quick, one bit more on the scenarios and going forward. So, climate change is just one factor in what you do. There are many other things, market objectives you have. How to frame that? This would be my question to you. What keeps you up at night? What conditions in your business, in your utility, what do you change? That is an outcome you

don't want to see because it threatens the functioning of your utility, of your system, of your community, whatever it is.

You can trace that back, on the one hand, to the climate scenarios, to the physical impacts. You can have subjective probabilities and that gives you at least one risk factor.

You need to consider the other stresses on your system and whether or not you're capable of dealing with it. And if not, you cannot assess what you're really vulnerable in. And then, you know, by that you can then chose which ones to focus on first, which ones to focus on second.

But in so many instances we don't know what the future is and so we need to go into scenario planning. I won't have time to go into this, I'll just skip through it. And just want to point here to robust decision making, which is a kind of form of analysis we have now good experience with, and has been used in this State, that gives you the space where you have fewer options, high uncertainty and high complexity of a system.

So, for things like utilities, that is probably the place to go with planning for the future.

So, all of this probably sounds like, uh-oh, a

lot of engagement, a lot of time we need to spend with talking with people. And in many ways, you might feel like we don't have that time. The enemies of process, people are fatigued. You know, we ask them a thousand times, no end in sight.

Well, here is the risk if you don't do that. The chances of doing something that makes things worse in the future. The chances you don't do enough. The chances that you miss opportunities, both from a business perspective and changing technologies, or simply waste people's time and money.

So, I think there are a lot of reasons not to do this and to invest in the time. It will save you time later.

So with that, I will just close because I have run out of time. This decision relevance does not happen by just handing things to people. It results from ongoing interaction between science and practice. We can identify what's climate sensitive, turn that into how much time do we have to get ready and, you know, identify approaches that are both robust, but also give us chances to change course in the future.

And in light of the great uncertainty, planning for multiple futures through the input of multiple internal and external perspectives I think is the only

way to get to something that is defensible as a decision and planning process. Thank you.

COMMISSIONER DOUGLAS: Thank you.

MS. RAITT: Thank you very much. Sorry to rush you.

Our next speaker is Larry Greene.

MR. GREENE: Good afternoon. My name is Larry Greene. I'm the Director at the Sacramento Metropolitan Air Quality Management District. And I am the Chair of ARCCA this year.

And I wanted to cover some things here about what we do, and why we were formed, and how we came together. ARCCA came together in 2012, as a result of a meeting that was being held in L.A., where it was recognized by all the players, some of the players are in this room today, that we needed to have a place where we could have regional conversations across California. And then, we needed a way for those regional conversations to inform State agencies, staff who were developing plans at the State level about what the regions were thinking on a range of topics that I'll be covering here, in this.

We started out with three collaboratives, the Bay Area, L.A. and San Diego. Quickly added Sacramento and Sierra Camp, which covers the Sierras.

And you can see that that covers about 80 percent of the State. Not everywhere. It doesn't cover Central Valley. Central Coast is now forming a collaborative, they're pretty much underway, now. And we have heard some ideas and thoughts about the North State.

I would say that each of these collaboratives is framed around the active agencies in those regions. The Bay Area has a different group of organizations than L.A. has, than San Diego has. And Sacramento and Sierra Camp I think are important because the other three are all on the coast, and we're very focused on coastal sea level rise. Where the Sacramento and Sierra Camp are more focused on fire, more impacted potentially by the drought, and by the urban/rural interface kind of issues. Although, everyone is impacted by that around water.

The working successes that we've done, we have brought a regional voice to the State since that time. We were named as a resource for State agencies in the Climate Change Research Plan, the Governor's Executive Order. And we are working on the Technical Advisory Group. We have a range of members there.

We have also been engaged by State agencies, by your agency on the climate vulnerability of natural gas

pipelines. We're doing work for you on that, for the CEC. And we have done a number of briefings in the Senate on the environmental quality, on adaptation, sea level rise. We've talked to the Little Hoover Commission, also. So, we have been called upon by the State at that level to brief about, and to be part of briefings about adaptation.

We have developed some real important resources, I think, for collaboratives, both in California and across the nation. We have a model tool kit for collaboratives. We are supporting this Central Coast Collaborative that you saw, with we're going down and helping them to get set up. And we have participated at the national level, also.

We have on our website, that you see here, principles of adaptation and collaboration that are very clear principles for how you put together collaborative efforts in California and how you should be thinking about adaptation.

And one key area that that does focus on, and we have had as a theme throughout our whole effort, is equity communities. How do we reach those communities? And each of the collaboratives has a part of their mission reaching out to those equity communities in the various parts of the State.

And in outreach and education we're very active in the national adaptation forums. We've worked at the federal level, also, on the federal programs.

We have hosted learning sessions on adaptation, funding through resilience bonds, and other types of activities.

And importantly, all the collaboratives regularly have, generally, quarterly meetings where their membership meets. I can't emphasize how important that is at our level.

For example, in Sacramento we've had meetings on water, we've had meetings on business resilience, especially around small business. We had one around energy and it was interesting that PG&E, and SMUD, and Roseville Electric were actually in the room, in a nonthreatening environment, where they could actually exchange information.

And some really interesting conversations came out of that because we were, you know, brainstorming that. But it was important because they had water folks, they had city and county folks, they had nonprofit folks. And some of the, like I said, environmental people that are not normally in the room with them, in that kind of conversation. We really had some robust developments that came out of that.

So, while it's important for ARCCA to represent the collaboratives at the State level and work with the State agencies, we have similar important work that's being done at the regional organizations.

These are examples of some of the efforts and work that we've done. The Bay Area, as you know, just passed the adaptation tax, $12 annual parcel tax. That's going to be really important for the Bay Area communities and their collaborative worked very hard on that.

The San Diego Collaborative is working with all their cities, but in particular with the City of San Diego, it's Climate Action Plan, and they're heavily involved in that.

And then L.A., of course the cool roofs effort came out of L.A. It's very important. We're trying to replicate that in Sacramento.

And one of the interesting things at our ARCCA meetings is we learn from each other and we've tried to take some of the lessons from other parts of the State, that have been relevant to, say, Sacramento. And we're trying to adopt that cool roofs initiative in Sacramento.

So, issues and lessons learned. This is the most important slide here, I think. State agencies are

organized around mission sectors, fire, water, agriculture. So, and cities and counties are organized around local issues, their areas of authority, and State and federal responsibilities.

But adaptation issues don't follow that framework. They follow watersheds, flood plains, forests, river systems, and we haven't developed, in the State, or even across the whole nation, a way to have those conversations at that scale.

So, what the collaboratives, they actually were filling the void for a place to have conversations around at the watershed scale or at the flood plain scale. So, that's the kind of things that happen often in our conversations.

We also found that many -- the adaptation conversation is easy because we've had flood agencies, we've had fire districts, and forestry agencies, and the State Water Board. So, people in California are familiar talking about those issues. And when we go out, it's not talking about some esoteric UN idea or plan, it's talking about what's happening in your forest, outside your door. People are used to that.

So, we have found that, for example, you have a very robust collaborative in the Sierras. You wouldn't think that, but they have a great conversation because

they've seen fires every year, and drought, and they have the tree die off. So, talking about adapting to climate change is an easy conversation up there if you focus on those particular issues.

And as I noted, that's really important, happening at the regional level.

However, what happens is that if the State has a particular topic they want to cover, different collaboratives have different information because one collaborative may be better with forests. Somebody else may be very familiar with sea level rise.

So, when we send out requests from the State for commenting on a particular document, we get conversations from different collaboratives based on their expertise. So, what you're really doing is you're reaching down into the local regions of the State and pulling the experts in those areas, with a regional voice on different topics, and different collaboratives depending on that topic.

So, what do we need? What can we do to help? Well, I think, personally, that the most difficult thing revolves around building a structure where collaboratives can regularly inform the State and they're called out. Now, we've already started that to some degree, as I mentioned earlier, about the

Governor's Executive Order and some of the work we're doing structurally. So, we already have a connection to the State agencies. In particular, to OPR.

But funding, and funding that administrative process, having -- you all know that when you have a nonprofit or that kind of an organization, and you go out and get grant for agencies, well, they want you to do work for those. You have a little bit of admin money and then you have to do the work.

What you really need is somebody to host the meetings, to do the web page, to do the minutes, and to keep the process going. And that's what all the collaboratives have struggled with that, but we have maintained that operation and we're continuing to work to try to find a solution to that.

So, if you ask me what the most difficult thing moving forward for the collaboratives is, it's funding that structural integrity over time, keeping that in place, so we have something to offer new members and people that are working there. And so that we can be there year after year for the State agencies, as they move. Because the State agencies are going to be there. We need to be there, too, as they move to the next climate plan, or the next plan that they're working on.

So, that's my presentation. Any questions?

COMMISSIONER DOUGLAS: I think not yet. Some come to mind, but I think we'll hold off until we hear from the panel. Thank you, Larry.

MS. RAITT: Thank you. The next is Neil Millar, from the California Independent System Operator.

MR. MILLAR: Good afternoon and thank you for the opportunity to present today.

The first thing I wanted to do is just spend a minute touching on the role of the California Independent System Operator, for people in the room that might not be familiar with our functions.

The ISO really has five major roles. Overseeing the day-to-day operation of the transmission grid to ensure that the system is reliable, and efficient, and effective. Operating the spot markets, both day-ahead and real time, for about 80 percent of the State of California and a little bit of Nevada.

Although now, also, with our energy imbalance market, we're reaching further afield into other states, as well.

We provide open access to the transmission system for our portion of the California grid. We manage generator interconnections to that grid. And we also plan and identify future transmission needs.

Now, we mentioned the infrastructure needs but,

more frequently these days, we're also exploring other, preferred resources as alternatives to transmission infrastructure.

And the department I'm with are responsible for the last two of those bullets, the generator interconnection processes and the underlined bullet about planning new infrastructure needs.

The session today has really highlighted for me where there are a lot of linkages between what we're hearing today and a number of the issues that we're having to come to terms with in terms of climate adaptation and how it affects the grid, itself.

The first issue, the most obviously I think, in some circumstances, is the physical resilience of the assets. The transmission system, itself. Can it survive the new and more extreme events that it's being exposed to?

The transmission owners within the ISO footprint are responsible for leading that initiative. And I think you heard a presentation this morning about their efforts. And on a later panel, several of the transmission owners within our footprint are represented. So, they're focusing there, particularly on the resilience of the assets that we already have and the design standards around those assets in the future.

That includes issues like sea level threat, fire risk, flooding and other risks that more extreme events can impose on those assets.

When we're looking at planning for future needs, we also have to look more broadly, though, at the other issues. The first is the impact of climate change on customer issues. That could include there are requirements for different kinds of loading, for increased air conditioning loads to accommodate high temperatures.

But it also brings with it the other issues that are behind the meter. One of our concerns, especially in the San Diego area, is the risk of high temperatures also increasing the frequency of monsoonal heat conditions. Where we could see high temperatures, humid conditions, but also cloud cover that decreased the effectiveness of the behind-the-meter rooftop solar generation that many customers are installing.

So, our forecast for what's needed from the grid could be completely off, based on what's happening in that scenario.

On the supply side, there are issues that affect those conditions as well. The most obvious is the risk of lengthened or sustained drought condition that limits hydro output, especially in areas where we're counting

on local hydro resources to maintain local reliability.

Last year, in our transmission planning process, Southern California Edison brought forward a proposal for just such an issue, to reinforce the transmission system to account for the risk of an even further sustained drought conditions affecting some of the resources. And we're having to do more work on that. Because the framework really isn't in place today to support coming up with an actionable decision on that kind of situation. But that's something we're working on.

The planning criteria themselves, that are used to plan the transmission system and to maintain reliability for customers, also needs a second look. Most of the criteria itself, developed over the last hundred years of experience of what provided a reasonably affordable system and a reasonably acceptable level of reliability.

Now, as we move to a pretty dramatic change in the conditions those systems can be facing, that means needing to take a second look. There are cases already in California where we've been developing additional planning standards beyond the minimum mandatory standards that are applied across North America to address specific concerns.

Those haven't reached so far, yet, into the situation of climate change. One better example is the criteria we developed specifically to address reliability risks in the San Francisco Peninsula area related to the earthquake risk. So, obviously a different circumstance. But the requirement to adapt and develop local criteria to provide acceptable service, it's a good example of that regard.

The other issue that I see needing to face for us as we move forward and take on a bit more focused look at what we need to do for the adaptation issue, is the alignment of the statewide agency coordination.

We're responsible for identifying certain needs, getting our board to approve projects. Some lucky utility or other party is then obliged to actually try to get those facilities built. That requires coordination throughout extensive permitting and engineering processes.

And if the State agencies aren't on the same page regarding the need to address some of these issues, then that can cause trouble downstream in actually getting those projects through to completion. So, effective alignment is pretty important there.

The last issue I wanted to touch on, though, isn't actually on these slides, but it ties to it, and

that was the issue around the scenario planning and the scenario approaches.

We follow scenario approaches pretty consistently through our planning activities, but looking at these environmental scenarios also draws out for us a very important issue, and that's the causal link between some of the parameters.

Historically, many of the risks we face tend to be treated as, basically, independent variables. You might have a heat wave. You might have a fire risk. You might have a monsoonal heat situation.

What I don't believe we've taking into account, yet, and need to focus on more in the future, is the links that it is the high heat wave that's also driving your fire risk, or your high heat wave, extended heat wave could actually be triggering more of the monsoonal heat wave risk.

That the scenario approach in understanding those causal links and looking at those scenarios in aggregate or more holistically, rather than treating each risk as an independent variable that is more or less unlikely to occur at the same time as another, that that would just be extremely bad luck that, unfortunately, it's not luck. There are causal links that we need to take into account. And that's one issue

that I think we need to move more aggressively on in the future is exploring those links.

And that's where I see us turning more to some of these environmental scenarios, climate scenarios that are being developed to help better understand the linkages.

So, those were just the opening comments. I'll be looking forward to questions later, through the session. Thank you.

MS. RAITT: Thank you, Neil.

Next is Whitney Albright from the California Department of Fish and Wildlife.

MS. ALBRIGHT: And I don't have a Power Point, so you'll just have to use your imagination.

So, hi everyone, my name is Whitney Albright. I'm a Climate Coordinator with Department of Fish and Wildlife. And as many of you know, the Department is responsible for protecting and managing fish, wildlife, and habits in the State, both for their intrinsic value, as well as for their use and enjoyment by the public.

So, given that mission we have a pretty wide variety of responsibilities. We do things from conservation and restoration to law enforcement, outreach and education, environmental review, and permitting, and so on.

And my role at the Department is to support climate adaptation and mitigation activities Department wide. So, I work with a lot of different staff across a variety of programs. I work on a lot of different types of climate-related projects, like different climate education initiatives, climate change research, adaptation planning, et cetera.

So, that's just a little bit, a quick background. And my presentation today might be a little bit different from some of the others we've heard in that I'm planning to talk about a few different climate adaptation projects that we have ongoing. And they don't necessarily all have a primary focus on energy, but I'm hoping to sort of draw the connection between conservation and these different energy issues. And talk about how we're using a lot of the same types of climate data and information, but for a slightly different application.

So, I picked three different projects to talk about just briefly today. The first one is the California State Wildlife Action Plan revision. So, the Wildlife Action Plan is a conservation blueprint for the State. And the first plan was completed in 2005. And we're required to update that plan every 10 years. So, we just finished this latest revision at the end of

2015.

And for the SWAP revision, we incorporated a lot of different climate change information throughout the revision process and also throughout the document, itself. We pulled in climate vulnerability information to help us prioritize which species and habitats we wanted to look at. We also pulled in climate change projections and impact information to help us evaluate what are some of the major climate-related threats and stresses to those different priority conservation targets.

And then, ultimately, we developed conservation strategies that can or are designed to, in part, try and minimize some of those potentially negative impacts from climate change.

So, one other reason that I wanted to mention the Wildlife Action Plan revision is that we also developed nine different companion plans to go along with the main SWAP document. And these are sector-specific plans that drill down a little bit deeper into the relationship between fish and wildlife conservation and various sectors.

So, there is a plan that's devoted specifically to energy. And that was developed by a number of our staff, as well as different partners. And that is

available in draft form, now, on our Wildlife Action Plan website.

So, that's just one example of kind of integrating climate change and energy sector issues, with a little bit of climate thrown in there as well.

The second project that I wanted to talk about, just briefly today, is the Desert Renewable Energy Conservation Plan, or DRECP. And this, of course, is not a DFW specific project, but has been developed over several years with a multitude of different organizations and agencies, and I'm sure many of you in the room today.

So, the DRECP outlines a desert wide conservation strategy that can serve as a framework for the long-term conservation of species, and the natural communities, and ecosystem function within the plan region, all while allowing for that renewable energy development type projects.

So the DRECP conservation framework was developed with climate change information to result in a more robust strategy, and one that's intended to work well under a variety of different climate futures. The framework, itself, pulls in a lot of different biological and climate information to make sure that the strategies we're ultimately developing are more

resilient and can help facilitate sort of the natural adaptation of species in that area.

The framework also has a lot of information that's intended to support development of climate smart conservation strategies and actions at the local level, as well.

So, the framework in general I think is just a really good tool and source for ensuring that the lands that we're managing -- or, the conservation lands that we're managing are incorporating different climate change considerations.

So, one quick example of the type of climate change data that was pulled into that process is some information about wildlife corridors in that region, and what they look like in present day and what they might look like when you start thinking about future areas of future habitat suitability. How do those corridors change?

And they did a pretty extensive exercise to think about what corridors are the most viable under the biggest variety of different climate scenarios and that can support, you know, a very diverse array of species. So, that's one example of climate change being pulled into this broader conservation framework.

And the last thing I wanted to say about the

DRECP is that it's also a great framework for implementing a lot of the adaptation strategies for biodiversity and habit that have been identified in the State's climate adaptation strategy, the Safeguarding Plan, as well as actions that have been identified in the Wildlife Action Plan. So, I think these are really complementary efforts and there's a lot of synergy between those.

So, the last project that I wanted to mention today is a climate change research project that was completed through a partnership between Department of Fish and Wildlife and UC Davis. And this is a climate vulnerability assessment of natural vegetation statewide in California.

And that assessment was built upon a lot of the different types of climate data that we've heard about today, different GCMs, and different emission scenarios. And it resulted in a lot of really great information for us, not just information on vulnerability rankings, but also which vegetation communities are most highly exposed to climate change, which may be more sensitive, which may potentially be more adaptive.

We were able to get a sense of what areas in the State, again, might be the highest risk of climate change and also what areas may be more resilient, or may

even be able to serve as refugia, areas of climate refugia in the future.

So, now we're working on figuring out how best to apply that information to various programs and policies within the Department. For example, we've started to think about how that data can inform our land acquisition practices, our grant solicitations, project evaluations and also, just generally, our conservation planning efforts at the Department.

So, I wanted to mention that project because it's something that we've been working on a lot lately, and also just to kind of introduce it as a source, another good source of climate information and data that's out there.

And that project did result in a final report that is available online. And we are currently working to get all the spatial data layers available on the California Climate Commons, which is a data platform that's hosted by the California Landscape Conservation Cooperative.

So, that's all I'll mention for now. Hopefully, it gives you a little bit of an idea of some of the climate related things we're working on and where there might be kind of a nexus to the energy sector.

MS. RAITT: Thanks, Whitney.

So, next is David Fink from Climate Resolve.

MR. FINK: Good afternoon. Thank you for having me here today. I'm happy to be here. My name is David Fink. I'm the Director of Policy at Climate Resolve. And we're a nonprofit climate change organization based in Los Angeles. Our mission is to make Southern California more livable and prosperous today, and for generations to come by inspiring people at home, at work, and in government to reduce greenhouse gas pollution and prepare for climate impacts.

And so, the sort of joke we say internally is that climate adaptation is the gateway drug to climate mitigation. And what I mean by that is when you start talking about reducing greenhouse gas emissions, you talk about global warming, it's a global problem. A lot of people have a hard time sort of contextualizing that, a problem so big. How can I be part of a solution when the problem is so big.

But when we sort of enter the conservation through adaptation and we start talking about climate impacts, and how climate change is changing people's neighborhoods and communities, people start to understand what climate change actually means, and they understand how they can be a part of the solution. So, that's been sort of our approach in terms of engaging

the public.

And so, I just want to start with -- so, the studies that Katharine was referring to earlier, that center around Los Angeles and project to the middle part of the century. And I don't want to sort of belabor this, but just to show that in the middle part of the century the number of extreme heat days, which is 95 degrees and above, doubles. And in some parts of the region triple. And if we look here, outside of the City of Los Angeles and in the broader region, you see places like Palmdale, in the northern part of the county, Redlands in San Bernardino County, even all the way up to Bakersfield in Kern County. And the number of extreme heat days is off the charts.

So in, say, Redlands, where right now typically you see 12 days above 95 degrees, we're looking at a projection of around 40 days. And this is also taking into account temperature, which is expected to rise three to five degrees in the region.

So, sort of looking ahead, we sort of looked at that and said, well, what can we begin doing now that will help us prepare for these climate impacts?

And so, one of the things we did was -- oh, well, let me take a step back and talk about sort of the public health implications of higher temperatures and

extreme heat.

And so, in an average year the number of mortalities attributed to heat are greater than all other weather-related events combined. So, heat is the biggest public health threat when we're talking about weather, in a typical year.

And so what this chart shows or this slide shows is that the regions that are most vulnerable to heat impacts, when you're talking about public health, are along the West Coast, the upper Midwest, along to the East Coast and into the Northeast.

And the reason for that is high variability. So in, say, Arizona and Phoenix, the average temperatures are much higher than they are in Los Angeles. And throughout the year they're much higher and in the summer they're much higher. But there's not high variability. And so what that means is there's not -- you don't typically get spikes in heat.

So, in Los Angeles, like we've seen the last two, three days, we've had temperatures over 100 degrees yesterday. In parts of Los Angeles it was 115 degrees or 112, you know, in that range. And so, three, four days before that, it was 80 degrees. So, we get these big spikes.

And so, in a place like Phoenix, or in parts of

Florida, where they have higher average temperatures, there's sort of slow rise throughout the year. In Central Florida, even though they average in the mid to upper 80s it doesn't get out of that range very much throughout the year. So, at the low end they get into the upper 70s, typically. At the high end, they get into the lower 90s. So, there's not sort of that high variability. So, that's when you see sort of the largest impacts.

In the early 2000s, when there was a heat wave in Chicago, I forget the year, I want to say it was 2005 or 2006, there were several thousand heat-related mortalities. And that was an example of a place that doesn't typically see these high heat phenomena. And so when there was that spike, people weren't prepared for it. The electrical grid wasn't prepared for it. And you saw a lot of sort of heat-related illness and mortalities.

And so, in Los Angeles one of the first things we did was begin looking at what can we do to cool down the city? And one of the ways we can do that is by reducing the urban heat island effect. So, the urban heat island effect in Los Angeles is pretty dramatic. And although it's not like in most urban areas, it's not monolithic. You have variability in terms of sort of

micro climates throughout the region. But we have a pretty dramatic urban heat island effect.

And so what we did was we started working with Los Angeles' previous mayor, Antonio Villaraigosa, and the city council, in 2014, and the Los Angeles Department of Building and Safety, the Los Angeles Department of Water and Power. And Los Angeles became the first city to require cool roofs on all new residential construction, as well as reroofs when over half the roof is being replaced. So, if you're replacing half the roof, half the roof or more, that triggers the ordinance.

A cool roof typically will cool down a home 3 to 12 degrees. The homeowner or resident typically sees between a 10 and 20 percent reduction in their energy bill throughout the year. It's typically in the 13 to 15 percent range, but somewhere in the 10 to 20 percent range. So, there's immediate benefits to the homeowner. There's immediate benefits to the electrical grid.

The other thing I want to note, in terms of energy efficiency, is when you're talking about a roof, a lot of people say, well, what we should do or what you can do is do things like a radiant heat barrier, or attic insulation, which is cheaper, and you get similar energy savings. Which is true, but you don't get the

urban heat island reduction benefit. So, we looked at it as without that benefit, you know, it's not as beneficial for a region that sees such a dramatic heat island effect.

And so, what we would like to see is a similar ordinance statewide, in climate zones where it makes sense. And just to note, the Cities of Pasadena and Chula Vista have replicated the ordinance since then.

And so, some other things we've been working with the City of Los Angeles and the County on is cool pavements, or cool streets. So, in the City of Los Angeles there's sort of that old saying, when all you have is a hammer, everything looks like a nail. And Los Angeles owns two asphalt plants. So, all they want to do is put asphalt down on all the streets.

So, sort of working within that structure, knowing that other materials probably aren't feasible, we've been working with them to develop a lighter slurry seal. So, the slurry seal is that top two inches that they typically shave off on a road. So, rather than full road reclamation, which happens every 20 to 25 years, where they tear it down, 8 to 12 inches down to the base, that when they just shave off that top two or three inches, which is a type of maintenance, they do that about every five years. So that goes down -- we

get a lot more bang for the buck if we have a sort of more reflective slurry seal. So, we've been working with the Bureau of Street Services to develop that.

Just about three, four weeks ago, in L.A. City Council, they passed a motion that will create a Committee on Cooling and Urban Heat Impacts. And that committee will be tasked with setting cooling targets for the City. So, in the mayor's Sustainability Plan, he has aspirational goals of 1.7 degrees of cooling by 2025 and 3 degrees of cooling by 2035. And so, this committee will codify targets, maybe those, maybe something more stringent. But that sort of remains to be seen.

We're working on expanding the urban tree canopy, as well as a cool parking lot ordinance that would require parking lots to either have some sort of cool coating or an urban tree canopy that covers 75 percent of the parking lot.

And that's it, thank you.

MS. RAITT: Thank you, David.

Next is Peter Gleick from the Pacific Institute.

MR. GLEICK: Thank you. Good afternoon, everyone. I hope you're still awake. It's been a long day. There's been a lot of talking. I appreciate the opportunity to come today.

I'm Peter Gleick. I'm the Director of the Pacific Institute in Oakland. We're a research institute. We've been working for a long time, really almost three decades on climate impacts, especially focused on water resources, fresh water, around the world and in California. We did some early work in 1990 on sea level rise in the Bay Area. And then, you heard about the 2009 work we did on sea level rise on the coast of California, as a whole, with the Energy Commission as part of their PIER work.

I just have a few minutes. I want to talk about four things pretty quickly. One is some ongoing work that we're doing on the links between climate change and the California drought.

The second is some work that we're doing on social vulnerability. Social vulnerability has been raised as one of the key issues here, but it hasn't been discussed much here. And I think there's not a lot of work going on. But we're doing some work in the context of the California drought that's relevant for climate change.

A little bit of background on some other work that we're doing and then the fourth thing I want to touch on is a couple of gaps that I think need to be addressed.

So, the first piece that I wanted to discuss was some work that we've been doing on the California drought and connections with large-scale climate, global climate change.

This is one graph from a study we did about a year ago, looking at temperature and precipitation records. Basically, each of the dots on the chart is a year in California, measured as temperature and precipitation. If you had a dot right smack in the center, where these axis join, it would be a year with average, long-term average temperature and long-term average precipitation. Anything above the X axis is a hotter than average year. Anything below is a cooler than average year. Anything to the left is a drier than average year. Anything to the right is a wetter than average year.

2014, the third year of the drought, is marked here. We're about to update this for the fourth year of the drought. You can basically see that the -- and, in fact, if we had marked all of the decade, all of the recent years in the last decade, they're all in this hot, dry corner. We're seeing very significant, statistically significant trends in temperature. Not just in California, but in the United States as a whole, in the U.S. as a whole, in the globe as a whole. That's

the issue of warming.

And we're continuing this work to look at the connections between changes in sea surface temperatures and the Pacific changes in atmospheric dynamics off the Pacific, due to changes in the Arctic ice melt, changes in long-term average temperatures, and those influences on the drought.

This is not a question of climate change causing the California drought. This is really a question of influence. What is the extent to which climate changes are now influencing the kind of extreme events we're seeing in California. So, that's one example.

We've done some work in the past developing social vulnerability indicators. We created something called the California Social Vulnerability Index in the context of climate change. And did a series of assessment by census tract in California, looking at vulnerability of populations to different aspects of climate change.

For example, agricultural productivity, water supply and delivery vulnerability measures, water quality measures. Heat stress, we just heard from David about some of the heat stress work that's been done in Los Angeles. The risk of forest fires is another index. Ecosystem functioning, and we heard about some ecosystem

pieces of this puzzle. Human health, recreation. A series of measures that together form this index of vulnerability of different populations around the State.

And doing that, it's possible to then map regional vulnerability. This is some early work we did looking at this. These maps are -- you can zoom in on them. They're on our website at the Pacific Institute. You can sort of see the URL up there.

And there needs to be some work to update this for changing population dynamics around the State, for changing indices of vulnerability. You can choose and select those indexes that are most important to you. But there are enormous vulnerabilities for different kinds of communities, under different kinds of climate scenarios.

Integrating this with some of the new climate scenarios that Dan Cayan described might be a useful thing to move forward on, as well.

And just as a couple of examples, this is populations vulnerable to -- oh, I can't even see it up there because I'm sharing my screen. This is high wildfire vulnerability. This is one for populations with particulate matter above certain levels. This is a population who's vulnerable to certain kinds of coastal flooding. You can look for each of these individual

measures at the kinds of populations with high, medium or low social vulnerability.

And this is another example. This is PM 2.5, particular matter. Under different climate scenarios, under current conditions and under future conditions around mid-century. And again, this can be extended to the new scenarios, the climate scenarios that are being developed.

The third piece of this is some ongoing work that we're doing right now. We're just about to release a study on the impacts of the drought on vulnerable populations in the San Francisco Bay Area. This is not a climate change specific assessment. It's mostly looking at the drought. Now, of course, the extent to which climate change and the drought are linked is relevant. That report, anyway, will come out probably in the next week or two.

We have a broader assessment underway, looking at the State as a whole and the impacts of the drought on equity. Looking at the price of water to different communities, including low-income communities. Water quality issues in the Central Valley. Access to water in the Central Valley. Of course, the story of East Porterville and lack of access to safe water in certain Central Valley communities has been a big story in the

news, during the drought. And we're looking at a broad set of indicators for equity and the drought in the State. And that report will be out sometime in the fall. Both of those were Foundation-funded reports.

We've done some work in the past looking at the impact of the drought on energy generation in the State. And somebody this morning also talked about this. What we looked at was decreases in hydroelectric generation as flows in California rivers and through turbines has decreased, through the first four years of the drought, ending in September, the end of the last water year. We're going to update that again this year, as the fifth year of the drought continues.

And what we looked as was the costs, the economic costs to California of having to burn more natural gas. When we don't generate hydropower, the marginal energy system in California is natural gas. We burn more natural gas and natural gas is more expensive than our average hydro cost, and the cost for California ratepayers over the last four years has been about $2 billion in additional natural gas costs.

And as an example of the links between climate and some of these issues we've been talking about all day, about a 10 percent increase in greenhouse gas emissions from the power generation sector because we're

burning more natural gas, rather than generating hydropower, which doesn't emit greenhouse gases. So, we'll update that report again at the end of this year, for the fifth year of the drought. And we're going to continue to look at these links between climate change and the drought.

So, finally, that was my last slide, but I just want to make one more set of comments about some missing pieces of this problem. We're not very good at looking at cross-sector issues. We think about energy over here, we think about water over here. Sometimes we do a little bit of work to try and integrate those things, but not very often.

And in the water/energy links, for example, we're not doing a good job with water utilities. There are energy utilities here, there's been a lot of discussion about some of the work that the energy utilities have been doing. But the water utilities, despite a great deal of effort to try and get them involved in the conversation about climate risk and the kinds of adaptation actions they're going to take, have not been that involved in the conversation. We need to improve that.

DWR is not. Anybody from DWR here? DWR is not here. The State Water Resources Control Board is not

here. The PUC is here, but it hasn't talked much about the water utility side of the puzzle, and that's a missing piece.

And the other example I wanted to raise was the oil and gas industry. California's an oil and gas producing state. We did a study last year, for SB 4, Senate Bill 4, that was required to look at the risks of fracking and oil and gas production. That was done with the California Council on Science and Technology, and LBL, and the Pacific Institute.

We did the water piece of that and we looked a risks to groundwater resources from, for example, the reinjection of produced water from the oil and gas industry. So, to what extent is the oil and gas industry in California going to be a player in this climate future that we've all been discussing? I don't think we've adequately thought about that, the oil and gas industry.

And, we certainly haven't thought enough, in my opinion, about risks to water resources. Groundwater is going to be a critical adaptation resource for water resources in general in California and, yet, there's the risk to groundwater resources from reinjection of produced water. Not to mention overdraft of groundwater in general.

So, those kinds of cross-cutting sectoral issues, I think need more attention and probably more attention than they've been given in general.

I'll stop there. Thanks very much.

MS. RAITT: Thank you very much.

So, now we have a little time for questions from the dais and discussion with the moderator.

COMMISSIONER DOUGLAS: You know, we probably have questions, but why don't you go ahead and we'll step in as questions come to mind.

DR. BEDSWORTH: Okay. Well, we have a long list, but I don't think we'll get through.

COMMISSIONER DOUGLAS: Right.

DR. BEDSWORTH: But I think we heard a lot of really interesting examples and I think very different of how folks have been incorporating science. And I guess I might deviate a little bit from the questions here, but I think this gets at a number of these issues and links to Susie's presentation in terms of thinking about transdisciplinary, and really about trying to work in a much more integrated way, rather than taking science or making a decision, or making a policy.

Just curious, what types of -- if there are examples in each of your areas, where you've started to move more in that direction of having a more

transdisciplinary relationship, rather than sort of the pipeline model that Susie was talking about?

DR. GLEICK: Well, as I described in my short presentation, we do a lot of cross-disciplinary, interdisciplinary work. We work on energy and water.

There is another piece to that puzzle, which is collaborative work, cross-group work. And again, Susie talked about it pretty extensively. We're doing a lot of the work on equity issues with some of the environmental justice communities in the State.

There hasn't been a great job at bringing in other voices to some of these kinds of questions. Some of us can sit and do research, but if we're asking the wrong questions, you don't get the right answers. And so, part of the equity work was designed to ask what questions should we be looking at.

Those indices, heat stress, agricultural impacts, the measures of social vulnerability were developed with environmental justice communities with conversations with local communities. And I think there needs to be more of that kind of cross-community conversation. Not just cross-discipline conversation, but cross-community conversation in order to direct some of this research.

COMMISSIONER DOUGLAS: You know, Larry, I saw

you reaching for your microphone or you might have been. But I think certainly the question of the regional collaboratives around specific issues, themselves generating scientific questions and the dialogue about what should the research agenda be. I thought you might have some good examples of that.

MR. GREENE: Well, two things that come to mind. One is that we did a very robust effort when the State Research Plan came out. We farmed that out to all of our members and I think we sent a very strong response back and, actually, a lot of our ideas and thoughts. Because the State Research Plan was not focusing on regional issues. And it was just an oversight and nobody had thought about that. So, we had a lot of input into that.

And the issues, the kind of issues that we were focusing on were issues around these watersheds and things. An example of how this plays out is we had a meeting that talked about fire and we thought we were going to focus on the impacts of the recent fires in the region, north and south of Sacramento.

But once we got into that discussion, we had water agencies in the room from both the federal -- I mean, not the federal, but the State and then the water agencies in the local area, and the cities and counties.

But we had SMUD and PG&E, flood control agencies, cities and counties. They all are part of the conversation about fire.

Even our chamber of commerce wanted to join our collaborative because of the economic impacts of smoke in the cities, because people don't go out and buy cars, and don't shop when we have smoke, they said. So, what can we do as a chamber of commerce to help with this issue?

So, that was not something I had thought about before, but was the result of a meeting we had with them, talking about the collaborative.

So, it's those cross-leveling kind of things that bring about thoughts and ideas that nobody's thought about before because they haven't been in the room together.

COMMISSIONER DOUGLAS: I have another follow-up question, just from the framing presentation, which comes to the issue of, you know, is it useful or how useful is it to think of certain issues as how much time do we have to really get on top of this issue before we begin to feel or experience the impact, and don't have the lead time we would want.

And I think I want to direct this towards Neil, but I think other people might want to answer. You

know, Neil, in terms of the reliability margins and planning that the ISO does, and it's responsible for, you made the point that that's done with reference to standards that were developed based on current conditions and over a long time.

And, you know, we've today seen that the climate scenarios are really showing us this tremendous increase in extreme heat days, for example, in very geographically extensive portions of the State.

And so, you know, the short question and you can take this maybe a couple directions but, you know, to what degree and over what time frame is the ISO really able to deal with that sort of thing?

I mean, if you decided tomorrow that you needed to look at reliability thresholds, well, what's the time frame between that starting point and getting through the different processes you'd have to go through?

MR. MILLAR: Sure. I'd like to just maybe touch on the timing issue. That for us, many of the issues that we're talking about are already here. One of my favorite lines out of the movie, "Twister", was Bill Paxton's comment about the tornado's coming, and he said, "It's already here".

So, many of the issues that we're talking about are not hypothetical or something down the road. The

way we look at these is by constantly trying to -- we go through an annual transmission planning cycle, assumptions that are coordinated with a number of State agencies. As opposed to one big collaborative discussion, we really rely on coordination. That certain assumptions are developed at certain times, they're refreshed, we use that work and it feeds back into the next year's cycle.

When we have issues that we have to deal with, that are already showing up within our immediate actionable time frame, we then have to look at what are the options that are either stop gap measures to get us through to a longer-term solution or make some assessment about what's a reasonable timing for that long-term solution.

So, the timing is a very important issue for us. Where, if we're looking at a major transmission line, seven years is quick and ten is often more reasonable.

Other stop gap measures can be built in two to three years. So, we have to look at the whole basket of solutions that we have available.

Our transmission planning process often gets mischaracterized or confused because we talk about a 10-year planning horizon, which is we won't move on a need that we see outside of ten years. That we assume most

solutions can be built within the 10-year time frame. But we do look at issues that go beyond the ten years. So, when we're building a 40- to 50-year transmission asset, we want to have some comfort that it has a need in the longer term. You can never be certain of anything that far out, but we have to do the best we can.

So, just then circling back to the timing of some of these issues, for us it's a constant improvement. It's not that we're starting with no collaboration or no coordination, it's how do we improve it in each year's cycle. In the past few years we've moved beyond the original coordination of renewable generation forecasts that came to us from the CPUC and the Energy Commission, to increasing the level of coordination on other inputs. Deliberately picking which sets of load forecasts we would use, so that the rest of industry is aware.

And then, starting to coordinate with other issues. More recently it's been -- and we started, in hindsight, about six months' too late, was starting to work on the gas/electric coordination issue.

So, for us, it's a constant evolution of improvement as opposed to starting from something from scratch. My comments today, though, is I did see areas

where I think we can sharpen the pencil on needing some better coordination discussions earlier, on certain issues. And those were really what I was looking for today was where are those issues that I can draw from and who should I be turning to.

Did that help touch on --

COMMISSIONER DOUGLAS: Yeah, I think it did. I mean, I think the coordination point, for example, the Energy Commission Demand Forecast, which takes into account climate scenarios is one of these inputs because you would need to use it to show that, you know, that demand might be doing something other than what we would expect based on the usual non-climate factors that we look at.

And at the same time, I think it's clear that we do need an interagency approach on how and to what extent we are ready to make decisions based on that information and under what circumstances. Because, you know, at the CPUC, then, utilities may come in with proposals to build assets that are potentially sized or upsized, or just designed to a different set of -- to meet a different set of demands. And over what planning framework, is that appropriate, for example?

MS. RANDOLPH: Yeah, in fact Neil and I were talking at lunch, just today, about the typical issues

with the demand curve, and there's lots of solar available, but does that shift when you're looking at monsoon conditions in San Diego, when you have a lot of heat, but a lot of cloud cover that comes with it.

And so, kind of linking those questions together in the planning process is critical.

COMMISSIONER DOUGLAS: Yeah, and the monsoon conditions, of course, don't just affect DG in San Diego or L.A., but they also can affect the utility scale product in the broader Mojave and Colorado Deserts. And that gets to pretty large numbers very quickly, in terms of generation.

MR. MILLAR: And one other comment to just make on that is that understanding how the demand forecasts are produced off of certain scenarios, I'm not sure we've been going as far as we should in looking at the scenarios that were behind the forecast. We can take the forecast and say, great, we've got that building block to our plan and we move forward.

Are we coordinating the rest of the assumptions, that they're consistent or inconsistent with the climate scenarios that help produce the forecast. So, that's another area I see as needing to do some pencil sharpening in the future.

COMMISSIONER DOUGLAS: Great, thank you.

Are there other comments just on the question of the utility of looking at issues through a lens of how much time do I have to solve this problem? I mean, I don't think that's the only criteria, by any means, that I would look at, but it could certainly be one of them.

MS. RANDOLPH: I actually have a question that might kind of bleed into the next panel as well, which is, you know, one of the issues -- one of the many sort of climate impact issues we see, we saw a little bit yesterday, with extreme heat event and impacts on the system in the sense of, you know, impacting transformers or other equipment, and causing outages.

And how is that or is that tracked and analyzed? Is it, you know, sort of our individual utilities kind of looking at the sort of the aggregate of as those -- in questions of load and in questions of demand, the increase in those events is going to require your reliability backstops to kind of be increased to deal with that. And so, how are we doing that? Are we doing it more on an individual, transmission owner basis, or on a system operator basis?

MR. MILLAR: Right now, both the ISO and the transmission owners, themselves, have key roles in that. The ISO, through its maintenance requirements, also tracks availability. But when it comes to the sparing

requirements and, especially for the lower voltage equipment, then the utilities are taking the lead role in developing appropriate sparing strategies and having enough equipment on hand.

MR. GREENE: If I can make a comment on this, too. This is an area where we have thought, even on our charts as we're talking about the risk of climate change, of what -- of not even putting heat on there at times, because what do you do about it?

Well, now, L.A.'s come up with the Cool Roofs Initiative. And you really can make that with the trees and other efforts, you can make a measurable difference with the heat in downtown areas.

So, now, instead of having something that we just have to live with, we have maybe -- so, in a situation like this. So, if you can reduce the heat impact by two or three degrees in a downtown area, what does that do with your energy impacts? And is that cheaper to do than doing some of the other high end things that you would have to do on the energy side?

So, now, you have to think about this in a more global context. So, as I thought about the heat, you have public health, business productivity, tree health, water availability because, of course, you have more water evaporation, and ozone formation from an air

quality point of view.

So, if you get in a room and talk about heat impacts from all those perspectives, you come up with maybe different kinds of strategies across different media as to what you can do about that. And then, you have an opportunity to sort of triage those and say, okay, which are the most urgent? Which do we have to do sooner? Which ones are cheaper? What's the best context for our community here and what we do?

So, that's the kind of conversation I think that's very helpful and that maybe we're not having enough of in California to really look at the context of this, and coming up with the best solutions, and maybe new solutions that we hadn't thought about.

MS. RANDOLPH: So, Commissioner, I just wanted to let you know we have come to the close of the time allotted for this panel.

COMMISSIONER DOUGLAS: All right. Well, I just want to thank all of you for your presentations and the thought and effort you've put into them. I really appreciate what you brought to us today and, again, thanks for being part of this.

MS. RAITT: Thank you. And so then, if our last panel could come to the front tables and we'll have a spot for you.

So, this is the second part of the Practitioner Panel. This panel is on Publicly Owned and Investor Owned Utilities. And we're just gathering at the table, for folks on WebEx.

Okay, so we can go ahead and get started. Our first speaker is Dr. Craig Zamuda, from the U.S. Department of Energy.

DR. ZAMUDA: Thank you. What a fascinating day. And I'm confident we have a good closeout panel to address you today.

I'm going to set the stage for the panel, which largely consists of representatives from various California utilities, but really talk about some of the work that we're doing at the Department of Energy with regards to climate resilience and preparedness. And, in many cases, doing that work in collaboration with the speakers that will follow me.

The President Obama's Climate Action Plan, released in 2013, really laid out two principle drivers that affect the work that we're doing at the Department of Energy. And one of those is really focused on the climate mitigation, which really isn't part of our focus here today as much as the other part, which focuses on climate adaptation.

That's driving the work that we're doing at the

Department. And I'll try to present an overview, really looking at five pillars of that work. Starting with our attempts to enhance the understanding of the impacts of climate change on the U.S. energy sector.

And as an example of that work, I have a picture here of a report. And, in fact, I have a couple copies I can leave here with the Commissioners. They focus on the U.S., looked at it from a regional viewpoint, adopted the information that was part of the National Climate Assessment, in terms of looking at climate trends across the country.

And then, looked at what the vulnerabilities to the energy sector would be and also provided some illustrative examples of climate resilience actions that are being taken.

So, if you haven't seen that report, I'd suggest you take a look at that. It's kind of like the 101 primer of what we should be doing and what the impacts are within the U.S.

But other areas we're also focusing on is developing improved methodologies and tools. You all have talked a lot about things that you're doing here, today. We also have, I think it was mentioned earlier today, worked to develop a clearinghouse. Not just for energy-related information, but more broadly, across

multiple sectors. The Climate Resilience Toolkit, if that's a tool you haven't accessed, I'd encourage you to do that.

But in addition to data and information, we are spending most of our time, currently, really trying to develop guidance to assist folks, such as you, in terms of doing climate resilience planning, guidance really focused on the energy sector. How to do exposure assessment, vulnerability assessments and how to identify cost-effective resilience strategies.

So, we have a couple products that I'll talk about in a little bit more in detail, in a minute, that we'll be releasing in the next few weeks.

But in addition, the third bullet here really focuses on downscaled climate science information. Largely, that's what we've been talking about here today. We're looking at that from a national point of view, recognizing that all decisions are really local decisions, and we need data that's useful, that's in the proper geo spatial context, within the proper temporal space that can help decision makers. So, we're increasingly investing and making that information available, and working with other federal agencies, such as NOAA, NASA, and others to make that available.

The fourth item, something we really haven't

talked to much today, about innovative technologies. But as the Department of Energy, this is what we do. This is our bread and bu9tter. We have 17 National Labs, two of which are located in your State. Lawrence Berkeley National Lab, Lawrence Livermore National Lab. These are developing a break through science with regards to application to the energy sector.

We also have energy programs that are investing in both the development -- the research and development of more innovative energy technologies. We recognize that the energy technologies that we're talking about today, to make them more climate resilient, were really designed for a different time and different place. They were designed and built in the 20th Century. We have aging infrastructure. We need to be looking at the gaps and opportunities for enhancing that technology so that we have clean, affordable, reliable and climate resilient technologies that can be deployed as we move through the years ahead.

And finally, in terms of doing all the work that's outlined above, we recognize that the federal government, the Department of Energy doesn't own and operate these energy assets. It's folks that would be represented here in the room. And so, we have developed a number of partnerships to reach out and work

collectively in terms of building a more climate resilient energy system.

We talked about earlier, it's been mentioned, this Partnership for Energy Sector Climate Resilience, so I wanted to spend a moment on that. Our goal here was to recognize that we had a certain degree of convening power to bring utilities to the table. We started with utilities. Recognized, I think Peter mentioned that this is an issue that affects not just the electricity sector, but the oil and gas sector. We started with the electricity sector. We thought they were ready. They were willing, they were willing to come to the table.

And so, we brought them to the table by establishing this partnership. A sustained engagement, so it's not kind of one-off workshops we do, but it's an opportunity to bring people together, to get them working collectively and collaboratively, sharing best practices, sharing lessons learned, and identifying opportunities for improvement.

We have 19 utilities that are currently part of this partnership. We look to expand that in the weeks and months ahead. At the same time, it's not an insignificant group to start with, supplying over 25 percent of the U.S. customers with service.

So, it's a fairly significant group and it's a group that's really leading the way among all the U.S. utilities in terms of addressing, looking and addressing the challenges of climate change.

The ones in yellow are the ones that are here in the room, they're the ones we have from California. But as you can see, we have a number of utilities from across the country, as the names imply on these utilities. From different -- exposed to different climate risks. Also, in different kind of governance structure between investor owned utilities, state munis, federal and co-ops. So, we have quite a representation in terms of the type of utilities and the types of climate risks that they're addressing. And it allows us kind of a broadband cross-representation of the nation in terms of working together on this common problem.

In terms of our work streams, one of the things that was a requirement of anybody joining the partnership was really a commitment to action. A commitment to develop a vulnerability assessment, look at their assets, identify their vulnerabilities and do that within 9 months of joining.

Within 18 months of joining, there was a commitment to develop a resilience strategy, a resilience solution to address those vulnerabilities.

So, if you look to the clock, we started this about 13 months ago. Nine months took us in, really, the February time frame. So, in the February time frame we were the recipients of about, at that time, 18 vulnerability assessments. We've been able to look at those, review those, identify best practices, look to see how different utilities are approaching this in different ways.

We didn't provide prescriptive guidance in terms of how to do a vulnerability assessment. We recognized that utilities were in different places when this partnership started. They had different risks that they need to address. And so, we were fairly flexible.

And so, we wanted to use this as part of, really, the learning curve for them and for us to kind of figure out what would that first round of vulnerability assessments look like? Recognizing that that was more or less a first round, not the last round. So, this will be a continuous improvement process. We'll build upon those vulnerability assessments as we move forward.

But we'll also learn from those. So, we did a summary review of those, in a report that we'll make public here in the next week or so. That really looks across those assessments, looks to see how we're

currently doing it, identifies opportunities for improvement, and highlights some of those best practices that were demonstrated, not just in your California utilities, but also the other partners, members of the partnership.

We're also taking that kind of information and other information to develop a couple guides. I mentioned this a moment ago. But here's the titles of these guides that will be coming out.

One is a deep dive on sea level rise and storm surge. It's a document, it's about a 100-page document, but it talks about not only how you could go about assessing vulnerabilities of energy assets with regards to exposure to sea level rise and storm surge, but it also identifies various tools that can be used. Cal-Adapt, for example, is cited in that report. And other tools that are being used more broadly across the nation.

So, there's a number of examples there. And that's a report that, although you all are far along in looking at sea level rise and storm surge, I'd encourage you to take a look at the report. If for nothing more than as to see how we've complemented the work that you're doing, but there's other work that's cited there as well.

And then more broadly, beyond sea level rise and storm surge, we're putting out a companion piece, a guide that looks across all climate threats, climate risks, and lays out a framework for doing vulnerability assessments, and developing cost-effective, resilient strategies.

So, those are a couple of products that have been part of the work stream coming out of this partnership.

The final thing I'll focus on is making the business case for resilience investments. So, we use the example from the northeast, so I don't get in trouble while I'm here in California. But coming out of Super Storm Sandy, energy assets were significantly damaged. We had a couple of utilities that are partners with us in this partnership, Con Ed, and Public Service Electric and Gas. As they identified their plan to move forward, to build back better, to build back in a more climate resilient nature, what they discovered is about 25 percent of their proposal was actually adopted by their Public Utility Commissions.

And so, they recognized they needed to do a better job of making the business case for these investments.

And so, we have a number of case studies

underway. We're reaching out and talking to public utility commissions. We have an effort underway, that's being led out of Lawrence Berkeley, that will be reaching out to the folks here in California to kind of learn how can we do a better job of characterizing costs? Not just the cost of the action, towards the cost of resilience strategies that you may be pursuing, but the cost of inaction. And equally important, how do you characterize the benefits of investing in climate resilience. Benefits not just to the utility, benefits not only to customers, but benefits to society. So, those externalities that typically aren't part of the equation.

So, we're doing a number of case studies, with our goal of really developing a methodology that could be made public, in terms of how to do a better job in terms of looking at these cost benefits.

I put this slide up just to make the point. This is actually pulling out some observations from the vulnerability assessments that were done from the California utilities. You can see the name of the utility going down the left-hand side.

And then across the top are a number of different categories in terms of the approach they used. Did they rely on sort of an internal assessment? Did

they rely on the literature, the examples of literature to kind of help do their screening analysis, their assessment? What was the scope of their assessments?

And sometimes it's varied, and sometimes it's looking at assets. In some cases, also looking at operations. In some cases, only looking at some assets, certain asset types, transmission, distribution, maybe substations versus transmission lines, et cetera. Or, did they look, take a holistic view of all their assets?

In some cases a qualitative assessment. In other cases, attempts to do a quantitative assessment.

The types of climate risks varied from utility to utility. As you might expect, if you have assets near sea level rise, you're going to be looking at -- or near the coast, you're going to be looking at sea level rise. If you're inland, that's not such a relevant issue to be looking at in your vulnerability assessment.

But the time frame is also interesting in terms of what is the time frame that you're looking at? Are you looking at doing a vulnerability assessment out to 2100, or do you have shorter time increments in there?

I think the key lesson there is that it's really a function of your assets. So, if you're looking at transmission, distribution, substation, transformers, things that may have a different life spans, you're

probably going to do an assessment that's kind of tied to the investment you're making. So, there's logical reasons for why things will vary.

The other thing I'd say is we're on a learning curve for this, so we all are looking for ways to improve upon the assets that are being done.

And in terms of those opportunities, my last slide here, just several items, many of which we've talked about today, only a few of which I'll kind of highlight.

But the need for more standardized climate scenarios I think is a key one. You've repeated that throughout the day. I think we'd agree with that at a national level, as well. We need to be understanding what are we planning towards. And then, to be able to take that type of information that has been presented here today, in terms of the many different databases, et cetera, and make that relevant for the decision maker, so they can do a better job of really characterizing their vulnerabilities, as we do a better job of estimating what that climate science and scenario is going to look like.

We talked in the last session about design standards. I won't talk about that. I talked a moment ago about the cost benefits. But I would say, on the

educating regulators, and I'll say it's vice-versa, it's not just educating regulators about the efficacy of investments -- and I should broaden that, as it says on the slide, not just the regulators, but other stakeholders, customers, society about the efficacy of investments.

One thing, and I use the East Coast example, when Public Service Electric and Gas went to invest in climate resilience, large portions of society weren't that interested in that long-term investment. They wanted to make sure their electric bill tomorrow didn't go up. And so, you have to balance this pay now versus pay later element of society.

For regulators, I think it's a two-way street in terms of better educating. And that is utilities need to know what are the criteria that are being used in terms of deciding what is the proper level of climate resilience? What are the appropriate investments to be making?

And I understand that's a work in progress, not just in California, but throughout the country, to get a better definition of what do we mean by a climate resilient utility? How much is enough? What are the proper criteria we should be using to measure that as we're reviewing rate plans, to pass these costs on to

the consumers?

The interdependencies, as Kristin, I think, noted earlier today the desire, as we're doing these vulnerability assessments, not just to look at the utility's footprint, but to look beyond. Look at the interdependencies of electricity upon these other sectors.

The example, and I'm going with that northeast set of examples. When Super Storm Sandy came along and knocked out electricity, it knocked out electricity to a number of elements, not just healthcare facilities, not just mass transit facilities, but also wastewater treatment facilities. So, billions of gallons of wastewater were being poured into the nation's waterways.

We need to be looking at these interdependencies between electricity and other sectors, as well as the interdependency of the electricity sector among itself. In terms of if your utility is relying on a supply chain to make sure it continues to operate, if you're relying on electrons being imported in from elsewhere, are they, other parts of this system also looking at climate resilience? So that if you're depending upon them, they're going to actually be there when you need them.

The final point is the nexus between climate

mitigation and climate resilience. There are a lot of things that we can be doing on the climate resilience side that have co-benefits in terms of climate mitigation and vice-versa. So, when we talk about energy efficiency that helps reduce greenhouse gas emissions, it also takes the strain off of the energy system in terms of peak demand.

When we're talking about distributed generation, when we're talking about micro grids, these are all things that have co-benefits for both mitigation and adaptation.

We ought to be looking for these opportunities to have synergy between our overall climate -- our approach to climate, both mitigation and adaptation.

And my final point, I guess, and it gets back to this issue of timing and how do we know the right investments to be making?

And I'll say, we ought to be thinking about what I guess could be labeled "climate ready utilities". Okay. So that when you're going to make these investments and you're looking out over that time frame, is there a way to, from an iterative process, take steps today? I don't want to call them stop gap measures because that sounds a little pejorative. But are there interim measures that we can take today that defers some

of that cost until a future point in time? But an iterative process, a climate ready process that we can build on those actions we're taking today to meet the short-term risks and be positioned that if we need to expand upon those same solutions to address longer-term risks, if and when we need to?

So, there's a number of examples from across the county that we can cite, with regards to the partnership where that exact approach is being adopted. Areas where in shortages of water, thermal electric power plants may be transitioning from once-through cooling to recycled cooling, and then to dry cooling, but they're doing that in kind of a step-wise fashion because there's no real need, right today, to make that leap to dry cooling. It's not cost effective.

So, I lay that out as just an example of a guiding principle that a number of utilities are using in terms of incremental approach. A responsible approach. So, you're not deferring action, but you're taking cost-effective actions today and doing it in a way that it's iterative and can be built upon as you move forward.

So, I'll stop there. I know I'm in the overtime slot here. So, thank you.

COMMISSIONER DOUGLAS: Thank you for being here.

Let me just ask, because I know a number of the panelists had to travel to come here, if anyone is anxious about catching your flight, you can go first. But if not, okay, we'll go in the order. Thank you.

MS. RAITT: Okay, so next is Nancy Sutley from the Los Angeles Department of Water and Power.

MS. SUTLEY: I'll do it from here since I don't have slides. Spare you all.

Thank you and thanks for the invitation. And I sort of what to start a little bit kind of where Craig ended. As we think about climate adaptation and resiliency at LADWP, I think there is this -- as we think about it, and idea that we think about resiliency all the time, along with reliability. And there are things that we do in the interest of resiliency overall, that are also beneficial from a climate adaptation stand point.

And I saw a quote from Mayor Garcetti, where he noted that Los Angeles is vulnerable to 13 of the 16 kinds of federal disasters. I don't know what the other three were that were not. So, this is sort of part of our normal practice and sort of identifying and considering those added risks as a result of climate change are also important.

And that, you know, some of the things that we

need to focus on and where are those areas of vulnerability, again as Craig noted. And we are starting to look at that. We've worked with a number of the local universities and trying to identify, and fill some of the knowledge gaps related to climate vulnerabilities, and adaptation to help us identify effective strategies.

We're on the steering committee of the L.A. Regional Climate Collaborate. And the Mayor, the Department of the City of Los Angeles, the Mayor's Sustainability Plan also set out that the City will do a climate adaptation plan by 2017. And that will be in conjunction with the City's Chief Resilience Officer.

And I'll talk a little bit about not just sort of LADWP as a power utility, but also as a water utility. So, I'll just start a little bit on some of the issues around vulnerability. And many of them have been touched on today. The first around increased heat days that obviously cause concerns about public health, but also a strain on our system.

And so, you heard reference earlier to some work that UCLA, Alex Hall did, looking at the downscaling of climate models particularly in Los Angeles, and looking at the number of days over 95 degrees. In the next 20 to 60 years it will double in that period of time. And

that the dense urban areas, like downtown Los Angeles, and the San Fernando Valley, will warm an average of four degrees. And this was some work that we helped to fund with, actually, with Recovery Act dollars.

The issues around urban heat island, in fact and I'll talk about that a little bit more in a moment, vulnerability to wildfire, our transmission system is long and crosses many mountain ranges and forested areas. And they're susceptible to brush fires and we've certainly seen the impact of those. And both in terms of kind of risk management costs, insurance costs, and actual outages, and we've had a number of those.

Sea level rise, we've obviously talked a lot about. We do have three coastal power plants and they are also, in different ways, potentially vulnerable to both sea level rise and sea surge. And as well, some of our neighborhoods along the coastline are low-lying and vulnerable to flooding. That will also have impacts on our power distribution networks.

We also do have some amount of hydro on our system, both the Los Angeles Aqueduct, which is a part of our water system and a net producer of energy because of hydro along that system. We also receive power from Hoover Dam, which we rely on as carbon-free power.

And also looking at the hydro pump storage

facility at Castaic. And I'll tell you that last summer we were quite concerned about the potential to not be able to rely on Castaic.

But water energy nexus, when it comes to climate adaptation, really isn't only about water for energy production, but really also thinking about how energy use and management factors into the management of our water system. And energy plays a significant role, obviously, in the water world in terms of moving -- gathering, moving, treating, distributing and the end use of water.

And for us in particular, as we look at different potential sources of water in a changing climate, they have different implications for both energy intensity of those sources of water, as well as a greenhouse gas intensity as a result of making choices about kinds of water that we will use.

So, as we look at kind of what do we try to do about this, there are things that have resiliency benefits, generally climate resiliency benefits, and things that we've been doing that there are those resiliency benefits.

When we look at sea level rise, I just would note that we are in the midst of eliminating once-through cooling and the use of ocean water for cooling

for our three coastal power plants. And that will have some -- will give us some additional resiliency in light of sea level rise, and really change in ocean temperature. So, we'll look at that.

I think, Commissioner Randolph, you asked about the strain on the power system over the last few days. We have just had a five-year rate increase improved and a big part of that was a power reliability program. Really trying to strengthen the local distribution network and to reduce vulnerability in the local distribution network by both replacing poles, and transformers, and a number of other things at the distribution level. That wasn't designed to deal with, necessarily, a heat storm. But recognizing that this system has been aging and is, therefore, more vulnerable when there are heat-related events.

And then I think looking at just diversity of supply is a resilience measure. In addition to moving from fossil fuels to renewable energy, as all of the utilities in California are doing, looking at also the benefits of distributed resources as providing some additional resilience. Whether it's local solar, energy storage locally, even electric vehicles as a potential measure that helps us to be more resilient in the face of potential disruptions. And we are working towards a

number of other types of storage projects.

We've also talked here about urban heat island effect and the kinds of things that we can do to reduce that, which also reduce energy use. And you've heard about the Cool Roofs Ordinance in Los Angeles. But I would just note that we continue to offer rebates for cool roofs.

And we have, for many years, funded in large part the City of Los Angeles' tree planting program, and work closely with the city plants to make sure that those investments will help us to save electricity.

And, of course, our energy efficiency programs are also looking at ways to make our homes and businesses use less energy, but also be more comfortable in the light of potentially increasing temperatures.

I'm going to talk a little bit more, as mentioned, about the sort of relationship between energy and water and the management of water in those choices. And as I said, we've looked at the energy intensity and greenhouse gas intensity of various sources of water that we rely on. The Los Angeles Aqueduct, as I said, is a net generator of energy. And actually last year, during the drought, for the first time really in 100 years there was no water flowing through the aqueduct to Los Angeles. So, we lost all of that hydro production.

We also looked at other sources of water, including imported water. Water we buy from the Metropolitan Water District, that comes from the California Aqueduct and from the Colorado River. And we looked at recycled water and stormwater capture, and desalination.

We looked at the relative energy intensity and greenhouse gas intensity and found that L.A. Aqueduct best when it comes to energy intensity and greenhouse gas intensity. And the next was recycled water and stormwater capture. And then after that, both the California Aqueduct and the Colorado River Aqueduct water because of the large amount of energy that's used to move that into Southern California. And finally, desalination being the most energy intensive and water intensive.

So, as we look at a future where cycles of drought and changes in hydrology make our water supplies more vulnerable, we will continue to evaluate those relative energy intensities and greenhouse gas intensity.

And then one other note on the energy side, the energy water side, there's been some analysis done as a result of the water conservation that was in standards, in place over the last couple of years, and some work

out of UC Davis. And we've looked at our own system and noted that due to these conservation efforts and reducing our water consumption by at least 16 percent, we avoided over 40 million kilowatt hours in energy use. So, there's definitely a big energy conservation benefit to water conservation.

And just the last thing I'd mention, again some others have mentioned, is the role of innovation and helping us think through these. And we have started and are in a partnership with the Los Angeles Clean Tech Incubator, which is located in downtown Los Angeles, and we share space with them.

And one thing that we're doing as a result of having to deal with potential curtailments as a result of Aliso Canyon, is actually holding a forum at the end of the month with the L.A. Clean Tech Incubator to help us focus on some of the innovative technologies that could help us deal with the potential loss of supply.

So with that I'll stop, thanks.

COMMISSIONER DOUGLAS: Thank you.

MS. RAITT: Thank you. So, next is Tim Tutt from the Sacramento Municipal Utility District.

MR. TUTT: Good afternoon and thanks for inviting me. I want to start with an apology and a caveat, if you will. I apologize for not wearing a

jacket today. The truth is, it was laid out and I just forgot to bring it out to my car when I drove into work.

But you can think of it as a kind of adaptation, if you will. It's a hot day out there. And as we get more and more hot days, there might be fewer and fewer jackets being worn. If that's a trend, I'm not sure where it ends. But I'm going to stop with just that.

(Laughter)

MR. TUTT: And then the caveat is, our real climate expert in terms of adaptation is Kathleen Ave. She's not able to make it today, so I'm channeling her. And if there are any really tough questions, I'm probably going to have to take them back to her to get the answers for you.

So, just a word about SMUD. I know most people in the room know about SMUD. But we're the fifth largest utility in the State. We're community owned and community led by a seven-member electric board. So, we're separate from any city or county government. We're our own local entity.

And that board has a fairly sustainable target or we wanted to develop a sustainable power supply. The board has defined and adopted that as meaning we're going to achieve a GHG goal of 90 percent below our 1990 emissions by 2050.

Right now, where are we on that path? We're at about 26 percent renewables and 50 percent GHG free resources. We have a big, 688-, 700-megawatt hydro resource, which is very useful for us, for both providing electricity that's GHG free, and integrating of the new renewables that we're getting. We have no nuclear, we have no coal.

We've recently signed some big new wind and geothermal contracts. And we've gone out with a solar RFO that's still being evaluated. And a non-solar RFO is under development. So, we're continuing to procure additional renewable energy.

So, clearly, for this purpose mitigation is not on the agenda directly, but it is our first mission. We have to reduce emissions to achieve ours and the State's goals. Like the Hippocratic Oath, do no harm first. Maybe in this case it would be do as little more harm as you possibly can.

But we want to -- we want to engage in this transition from predictable power sources, using fossil fuels that have the GHG emissions that are causing the problem to, at times, unpredictable or at least intermittent resources, like solar and wind, that have their own set of problems.

And one of the reasons we're doing this is

because we're a significant contributor as an industry, and as an entity to the identified environmental challenge, climate change. SMUD's power plants represent pretty much the largest point sources of GHG emissions in the Sacramento area. I presume a lot of our plants are also the largest point sources generally in their areas. There's industrial sources. But in SMUD, really, it's the power plants.

And we also can be a very significant actor in resolving these challenges. We have a lot of lower GHG options that can be developed, as you have heard. There's fuel switching, renewables, energy efficiency, and so on. We can be the fuel switching option for a variety of other GHG sources, as well. Transportation, water and space heating. We will and can play an increasing role in addressing climate change, reducing GHG emissions by embracing and managing the widespread electrification of our economy. That's our goal.

So, that's first. But we also have to be prepared for impacts of the already-in-the-pipeline change. And at SMUD, we're getting ready on three basic fronts. The first is organizational. We now track impacts from climate change, explicitly as an enterprise risk. We have one of those, you know, red, yellow, and green, and orange maps. And the impacts of climate

change on our operations is explicitly on that map. And it's sort of a long-term risk, so it doesn't change much at present. But it's there, ready to be part of the enterprise risk platform.

We've also developed an initial analysis of climate impacts on our system. That was done in 2012 and 2013. And there's a document available, if you're interested in it. We're updating that document this year and we plan to update that every four years, as the science changes and improves, and we get more information about what we need to do and what the impacts actually are.

We have a policy, now, of using the results of that impact analysis in all long-term planning, greater than five years out, at SMUD. So, when we do an integrated resource plan, we have to at least consider and account for the results of this impact analysis on our system.

And we participate in the community collaborative analysis, as Craig has mentioned, and I'll cover a little bit more later.

So, the second front I would say is sort of, again, staying with the medical analogy, an "acute" front. Helping make our community resilient to the increasing probability of disasters as climate change

progresses.

So for SMUD, there's two main concerns. There's urban heat storms and flooding caused by the chance of atmospheric rivers greater -- you know, a lot of rainfall in a short period of time. SMUD is a very -- Sacramento is a very flood prone area, as you know, and also in the hot Central Valley.

So for those we see potential disasters happening and we're trying to get ready for them. We've doubled the incentives for our Cool Roof Retrofit Program this year. And we're seeing greater uptake in that.

We're examining electrification of bus routes, particularly in disadvantaged community areas, trying to establish resilient corridors, we might call them.

And we're looking with local governments on local hazard mitigation plans, so identifying key resources that we'll need for resiliency in disasters. Again, particularly for the disadvantaged. Because, I mean, many of us can deal with like an urban heat day. We have air conditioning, we might have a pool or something of that sort. But there are many people in our community that can't easily deal with those and they need an opportunity to go to cooling centers, where the power will stay on, even if the power goes out at our

houses.

And then chronic, looking at the long-term trends that impact or affect our resources, infrastructure, the ability to deliver the essential provide that we provide as reliably and as affordably as we do today, hopefully, but with significant increases in sustainability.

And the main issues there, again for SMUD in the Sacramento area, are wildfires, changes in wind patterns, changes in hydrology, and impacts on the supporting infrastructure outside our service territory. And we're not a natural gas utility, but we do use natural gas and the natural gas, we get it through the PG&E infrastructure. And we know that there might be some vulnerabilities there that could prevent us, in some circumstances, from using our power plants. And that could be a problem if the power is needed.

So, what we're doing there is we're looking again at mitigation efforts. We're doing a lot of research on bio-sequestration, geographic-sequestration, product-sequestration. Making some valuable or viable consumer products out of CO2, and other materials in the environment.

Fuel switching, like I said, moving to renewables, energy efficiency. Addressing high global

warming potential emissions. We've identified that commercial refrigerants are an area where we could work with our customers to switch to different kinds of refrigerant systems and, hopefully, reduce the impact of that high GWP pollutant. And also, at the same time, maybe get a little bit of efficiency out of it.

Collaborations, as I mentioned, we are a member of the Capital Region Climate Readiness Collaborative. I think that they're meeting today and I think Kathleen is chairing that collaborative this year. Obviously, that makes us or puts us as part of the Alliance for Regional Collaboratives for Climate Adaptation here in the State. And we've also participate in the Partnership for Energy Sector Climate Resilience that was mentioned by Dr. Zamuda.

We're doing research in terms of hydrology, on the potential for tree thinning. Not only to reduce wildfires, but also potentially increase the amount of flow in the streams. That seems to be an effect that works in some places and doesn't work in other places. So, we have to do a study just for our hydro resources to see if it makes sense.

And then I'll give you some key lessons. This is really -- we've noticed that this is organizational change that's happening, including the long-term impacts

of climate change and planning. It's not what's been done before and it requires organizational acceptance. It's not necessarily easy to just come out with the idea that this is a good thing to do and have the organization say, yeah, we're on board. So, there's an important effort to get everybody included in deciding to move in this direction.

Another key lessons is that there is a lot of benefit in community collaboration. We learn from our community partners and they learn from us. A lot of the avenues or measures that we identify would be something that we couldn't do alone. We can be a major partner, but we can't make the things that we see might be useful for our community happen all by ourselves. That collaboration is key.

And then I'll close with one other lesson, which I think Nancy mentioned as well, and that is there's really a need for a lot of innovation to make sure that we understand what measures are going to really work for us as we move forward.

And I'll just mention two, not are SMUD related, but caught my eye recently. There's a retired guy in Nepal that's making artificial glaciers for remote, high desert villages, where the glaciers -- the glacier melt is what they depend on for their summer water. And

those glaciers are disappearing. So, he's simply going up to strategic places in the mountains and building walls, rough walls that channel the water rainfall into shadowy areas, where the water freezes and builds up into a glacier. And, you know, that's a great low-tech idea for that area. I doubt that it has much relevance here, but we need those kinds of ideas as well.

And then, finally, a kind of adaptation that is for a kind of climate adaptation that's already happening. I was at a recent meeting of the Clean Energy States Alliance, in Minneapolis, Minnesota. And if you've never been there, they have to adapt to the severe cold climate that they have every year. And so, their downtown buildings all have networks of walkways that are -- so that in the wintertime you can go miles through downtown Minneapolis without ever going out into the cold winter weather.

And, you know, there are ways of addressing the changes that we're going to see with innovative ideas.

COMMISSIONER DOUGLAS: Thank you, Tim.

MS. RAITT: Thank you, Tim.

Next is Scott Tomashefsky from the Northern California Power Authority -- Agency, excuse me.

MR. TOMASHEFSKY: Thank you, Heather, and good afternoon.

And to Tim's point about the coat, I would remind you that the person for which this room is named for had a rule that if it was over 100 degrees that there was no coat required. Although, I violated that today. So, I'd just mention that as a point of reference.

I have a unique role, I guess, on this panel, in terms of the 15 members I represent, combined, don't even close to the peak load of anyone else that's sitting on this table. So, part of my objective is to address the question of any concerns about publicly owned utilities being involved in adaptation strategies.

It's one thing, DWP and SMUD are obviously going to be involved in that in a number of different ways. But once you get past those two, it becomes a question of what happens below the line. And the line does go fairly low in terms of size. Our smallest member is a peak load of 4 megawatts and our largest member is around 400 megawatts.

So, the range of what we represent, we have about, roughly about 1,200 megawatts of load, about 3 percent of the State's load from our 15 members. We go -- we're pretty typical of the California consumer. We have Palo Alto, Santa Clara, we have Alameda, Port of Oakland. We go down as far south as Lompoc. We got

into the Central Valley with Redding, and Roseville, and then we go into the Sierras with Plumas Sierra and Truckee/Donner. We also have Healdsburg and Ukiah in the Bay Area, as well. So, it's a pretty good snapshot in terms of what we do.

I think one of my objectives here is to just kind of provide a little bit of a snapshot of how we are involved in some of these adaptation activities. But I also want to highlight some of the things that we have been addressing. Which, one of which was actually highlighted at the end of the 2015 IEPR, in terms of wildfires, and so I'll start with that.

It's one thing to deal with your plants, we have a geothermal plant in Lake County, about 100 megawatts. We have a hydro plant in Calaveras County, about 250, 260 megawatts. And then we have a gas plant in Lodi, around 300. And a couple of other smaller ones.

But when we deal with vegetation management, especially as it comes -- as it relates to the hydro plant and geothermal plant, last year was very different. Because in the course of about three days we were subject to two major wildfires.

The one in Butte County was interesting in the sense that from what we understand Cal-Fire basically had given up on the Highway 4 corridor because the fire

was so intense and, fortunately, the wind shifted. So, we would have lost that thing, in addition to communities just being devastated by those fires. So, we were lucky there, in some respects.

In Lake County, at the Valley Fire, we actually -- we had employees lose homes. We had the fires actually come up to almost the plant site. So, we actually didn't have any damage to the plant, itself. But the transmission system that was bringing the power down to the rest of the grid was basically put out of play.

And then Cal Plant had major issues in terms of they lost cooling towers, and to the tune they've lost about 200 megawatts of load over about a six-month period. And from what we understand, there's about 50 megawatts that's not going to come online again.

For us, we lost about three days and we actually had our crews -- we had crews from each one of our members send trucks up and they rebuilt 21 miles of transmission lines in about three days. So, it was pretty impressive what had happened in that capacity.

But what it did do is it really highlighted part of the concern that we've been raising, not only at the Air Resources Board we've been raising it, and in the congressional world, we've also been raising it at the

State Legislature in terms of trying to align the funding so that you don't take the finite funding of resources that are basically tied towards a combination of prevention and wildfire protection. And, basically, deferring the fact that you have to deal with a lot more firefighting, which takes away from your real preventive measures that really take care of the problem.

So, what we've seen is when you start to look at the issue of climate change and trying to get to our greenhouse gas goals, as much as -- we've done very well as a power sector. In fact, I think the Chairman's actually said that in the last couple of weeks, how we're 20 percent below 1990 levels as a sector. There's no possible way that we're going to get to a 2030 target if we don't deal with the wildfire issue.

So, that's been a big issue for us. In the congressional discussions we've tried to get emergency aspect of that put into the -- taken out of the main budget. I think we're making some progress there, but it's not a done deal.

On the State side, we've been dealing with trying to look at it from perhaps one potential way of using the Greenhouse Gas Reduction Funds to actually do something that would have some lasting effects. So, that's also in play.

And, of course, given how the last auction went in terms of dollars, that raises questions as to the viability of that funding source.

But the bottom line is that's a very important area that just has to be reflected. And that's been an organizational issue for all of us. It doesn't matter how large or how small. That's our little way of contributing, regardless of what size you are, and who shows up to meetings, and who can participate. So, I wanted to just kind of share that.

Then, I'll get more to the member activity. From the wildfire stand point, actually we can start north. Redding was involved -- the City of Redding was actually involved in the Western Shasta Resource Conservation District. In fact, the person that was the principal author for that now works for the utility.

But one of the interesting aspects of that was really related to wildfires, also dealing with erosion and other things like that. Also drought, of course. So, that's been a big, a big issue.

Interesting to that is that some of those activities were actually an offshoot of a WESTCARB project, which is basically managed by the Energy Commission. And so, the idea behind having a water adapt, an adaptation plan, along with forestry, was

really a product of that. Where you run into problems, in some respects, is what happens in terms of next steps? Because a lot of these things are funded by grants and other things like that.

But then, when it comes to the next step, in terms of how cities and counties deal with this, it becomes sometimes difficult to address the funding of how you get to the next step. And especially when you're coming off of the recession of 2009. It was bad enough to deal with cities and counties being underwater, but they're very, very careful in terms of how they deal with discretionary dollars. Much more so than they probably ever were.

So in this respect what you'll find is you'll find the adaptation strategies that happen at the State level are really helpful things. And to the extent that those things can be applied at the county and local levels, those are good things that happen.

So, this is always about partnerships. This is very different than dealing with the we're all going to be at a 50 percent renewable by 2030. This is not an individual direct, this has to be done by partnerships. And it's never going to be something that's accomplished by any individual utility.

And even when you look at it that way,

especially as you get to a smaller community and, actually, even the large ones, Nancy had mentioned it, it really becomes a city issue. It becomes, how do you deal with it comprehensively. It's not a matter of how is the utility going to address this question. That's really not the question. It's how does the utility help in having the city, and the county, and the region deal with those issues? We're always part of the solution, but we're never the answer. We're part of the answer.

So, from that stand point I wanted to shift towards, with the rest of my time, towards the sea level rise issue. Which, of course, becomes much more interesting for our members that are around the Bay Area, of course.

So, as I look at that, I guess as a starting point I wanted to mention that Measure AA, which passed as a parcel tax, that is in play, has a lot of restoration activities and also, in addition to that, flood control type of operations that are going to help address some of those issues, especially for Palo Alto, as they deal with areas in the South Bay. With San Francisquito Creek, which I can never say correctly, so I'm just going to say that slowly.

Because that creek feeds right into the Bay and then goes right through East Palo Alto and then into

Palo Alto. So, they actually have some monitors on their website that show where creek levels are at any given time.

They also have, with respect to Santa Clara, some of their transmission lines off their system are in the extreme south part of the system. So, even though they have been addressing things like water table issues for years, they're actually ahead of the curve just by virtue of the fact their water table is high. So, they have concrete poles, and steel poles, and all the casings to address that issue with respect to the transmission system.

The distribution system becomes a little bit of a different question. But from a transmission system, it works out pretty well.

And I'd also note, at least, that Santa Clara has been designated a tree city for about 27 years. So, I guess we could say they're about two decades ahead of the climate adaptation question from that stand point, just to throw that in.

MS. RAITT: Just to let you know, we'll need to close soon.

MR. TOMASHEFSKY: Okay, thank you. Just briefly, then, with the case of Palo Alto, the Climate Action Plan has guiding principles for sea level

response, so that's built into what they have addressed. That's a -- there's an extensive amount of adaptation information that's include in there.

With respect to the Port of Oakland, I wanted to share some thoughts, just a thought or two there. They are addressing the issue that projected sea level rises by 2050 would basically inundate the airport, itself. So, they are taking actions to deal with that. They're working on rebuilding a perimeter wall around the airport to deal with seismic risk and also sea level rise. So, they've got a lot of things going on as well.

I'll just close by saying that in terms of the San Francisco Bay Development Commission, we have a city council member from Palo Alto who's on the board. We have a member of the Board of Oakland, as part of their policies for a Rising Bay Working Group.

Palo Alto, their mayor is also part of the San Francisquito Creek JPA that's dealing with flood control issues on that. So, there are a lot of folks that are involved in these things. They're very much done at the local level.

But what we do see is a lot of those efforts is happening at the regional level. And so, the stuff that you're doing to bring this material up and forward I think is very timely. And we're happy to be part of the

process. But probably a little bit below the radar from what everyone else is here. Thank you.

MS. RAITT: Thank you very much, Scott.

Next is Barry Anderson from Pacific Gas & Electric.

MR. ANDERSON: Okay, great. Well, thank you and good afternoon, everyone. We really appreciate the opportunity to come here and speak, and share with you what we're doing in this area.

Myself, I'm the lead for emergency preparedness and response for PG&E. And I can tell you have a keen interest in this. We're talking about changing climate and I can tell you it's just been busy the last few years, between wildfires, El Nino, extreme wind events, the Napa earthquake. So, these type of things are ongoing on our system.

Our general approach, we provide energy to nearly 16 million Californians. We understand our responsibility to both reducing our carbon footprint and to adapt to changing climate conditions. Doing so is integral to our efforts to provide safe, reliable, affordable and clean energy.

At PG&E, we've been investigating the potential physical risk of climate change to our system for several years, now. We've identified a number of

potential risks to our business, including flooding, sea level rise, temperature changes and wildfires, that I mentioned. As we work on these risks, there are four aspects to our approach.

The first one is all about emergency preparedness and having good integrated plans across the company in order to respond to these events. We take an all hazards approach and that allows us to prepare.

From a perspective of external stakeholders, we engage with federal, state and other local external partners. As an example, we joined Dr. Zamuda just last week, and other utilities, at a workshop that DOE sponsored.

For longer term factors, and I'm going to talk a little bit more about this in a second, it's about our risk assessment process, and how we prioritize risk and make sure that we have plans in place to control them.

And finally, we maintain in-house climate scientists, meteorologists. This team has real great insight into how wind, water, sea level rise impact our assets and it's something that is real key.

So, our risk assessment process, we call it Natural Hazard Asset Performance, which is called NHAP, fancy acronym. It really is all about a cross-functional team, so all of our lines of businesses

participate in this. And we evaluate our assets, geospatially across our system. And we do it for different treatments. And the treatments are the things we've been talking about, but also including tsunamis, volcanos, sea level rise, floods, extreme temperatures, extreme wind, earthquakes. And that covers all our assets, both gas and electric, but also our IT assets and our buildings, as well.

This slide also shows a structured process for that. We identify potential impacts to our assets that would enable potential affected business units to evaluate these risks and develop necessary plans and adaptation strategies.

This slide shows the structured process that we're talking about in order to conduct our risk assessment. We're currently in phase two, when we consider climate change. And we're assessing our assets against different climate scenarios, and expect to complete this work in the near months, and move to phase three later this year.

The results feed into our emergency planning and response activities. So, we continuously improve our system. An example would be our earthquake modeling, where that we've got damage models now, under different scenarios of earthquakes that provide outputs 15 minutes

after a quake. And it tells us how many resources we would need to deploy in order to respond in a certain period of time.

When you run those scenarios, if the response time requirement is long, that's unacceptable to our customers and we have to look at mitigation, hardening strategies, and so forth. So, it's that type of modeling that we're looking at doing for these scenarios that we've been talking about today.

And it also provides you an opportunity to do that cost benefit analysis in terms of where's the best way to invest within the infrastructure.

I'll move on to collaboration on resilience. We're partnering better so we can understand the risk. We recently partnered with the researchers at UC Berkeley to assess the potential impacts on our natural gas system from the long-term risk of sea level rise, coupled with an extreme storm event and flooding. We've overlaid sophisticated maps on our gas transmission infrastructure to assess potential vulnerabilities and impacts.

The research also looks at the San Francisco Bay Area, Sacramento/San Joaquin Delta, and Coastal California. It's still a work in progress, but when complete will help us better understand and plan for the

response to these climate change risks. And this research is funded through the CEC program and we're grateful for this level of support.

Collaborating on resilience. We also studied potential impacts on our electric assets. We participated in the Bay Area Council of Economic Institute report that found that a super storm and the associated flooding would have over a $10 billion impact to the Bay Area economy. The report also included PG&E's estimate that we'd have disruption to six substations that could result in an economic impact of $125 million. An impact mitigated by PG&E's redundant electric system.

We're collaborating with DOE and EPRI to assess vulnerabilities and share best practices. We're engaged in numerous local studies and initiatives. A good example of this is we're working with San Mateo County on a sea rise level effort.

And we also understand the critical need for funding to support local resilience measures. We're pleased to support the Measure AA for a clean and healthy bay, which voters recently approved. It will raise $25 million over the next 20 years, to total of $500 million to fund critical flood protection and conservation projects around San Francisco Bay.

We also announced a new Resilient Communities Grant program. We're dedicated $1 million, over five years, to support local climate resilience planning efforts. The program will launch next year. It will use a competitive grant process to select projects.

So again, we thank you for the opportunity to participate today and look forward to your questions.

COMMISSIONER DOUGLAS: Thank you.

MS. RAITT: Thanks.

Next is Adam Smith from Southern California Edison.

MR. SMITH: Adam Smith with Southern California Edison. Thank you very much for having us. Very happy to be here today and share some updates from our adaptation efforts.

Just briefly, to go over some of the goals and basically the reason why we wanted to join the Department of Energy Partnership. We're focused on three things. You know, assessing current vulnerabilities to climate change on our operations and physical assets. Addressing existing vulnerabilities with cost-effective solutions where we find those vulnerabilities. And then, integrating climate data into all relevant decisions at the utility.

You know, we approached the DOE Partnership,

really, as an opportunity to conduct a kind of basic gap analysis between the current levels of resiliency, you know, of our infrastructure, which is based around historic extreme events, and averages, and kind of engage directly with the State's Cal-Adapt tool. And that's what I'll be focusing my presentation on today, at the request of some of the people up there on the main stage.

Our framework for this climate impact analysis, you know, we kind of moved from choosing the right data to doing something at the bottom there. The climate impact analysis I've categorized as kind of the first three of those bubbles. We moved from kind of, you know, picking out the right data, which we had -- we were the lucky beneficiary of a State that's done quite a bit of thinking, and staff at the CEC that's pulled together quite a wonderful Cal-Adapt tool.

We basically scrapped those data layers from the Cal-Adapt tool, mapped them directly over our infrastructure, and we were able to kind of identify, in many instances, what we've been calling the climate risk gap. This is kind of that gap in between current levels of resilience and the impacts we feel, and from the science we've been able to engage with, our infrastructure and our operations will have to deal with

in the future.

That final bubble on the bottom right, "determining the cost-effective actions", that is -- I guess we've kind of conceptualized that as, you know, kind of where the impact analysis ends and the real resilience planning begins. We hope to explore a suite of adaptation options to close that climate risk gap I was talking about. We think the DOE collaboration is going to be absolutely great on this front because you have lots of utilities, from all over the United States, asking these same kind of questions.

We also hope, as it was kind of mentioned a little earlier, to engage with both POUs and other stakeholders. I thought the urban heat island presentation was absolutely wonderful. We are also very focused on that specific threat and we'll be kind of looking across, you know, hopefully, not just energy sector actions that can kind of increase resilience. But there are lots of, also, you know, other things like cooler pavements, urban forestry that foreseeably could help reduce the vulnerabilities that the energy sector will be facing, but also carry co-benefits.

So, that's something we want to keep in our minds as we're transitioning into the second phase of the DOE Partnership.

Quickly here, an overview of our impact analysis scope. We based -- the Cal-Adapt data is absolutely great because it includes multiple, multiple years, all the way out to 2100 in some cases. We tried to take time slices, focusing in the near term out to year 2030, 2050, and then in the out year, 2085. Many of the datasets go all the way to 2100. The fire risk maps stopped at 2085. I'm 95 percent sure it was the fire risk maps. So, we decided that was an okay place to kind of cleave it off there. So, we had representative time slices, three in a row, kind of spreading the -- you know, all the way out to the end of the century.

The scale, we focused on SCE service territory, but we have data for all of California. As you'll see, some beautiful pictures in a second. The infrastructure we focused on, generation, transmission, substations and distributions. You'll see right there how we kind of focused.

This was kind, as we viewed it, the high level prioritization right off the bat. We looked at the big stuff. The stuff that has really, really big footprints as far as impacts on our customers. I'll talk about further prioritization in a second.

The climate impacts, like we said, we kind of pulled up the Cal-Adapt website. I'll get to that in a

second.

You know, talking about this adaptation effort as sort of a gap analysis we have -- you know, this is happening in a context of a utility that's doing, you know, quite a bit of the kind of all hazards approach to business resiliency. We have internal groups that are doing, you know, El Nino studies, focusing on the impacts of bark beetle. We really, here, wanted to engage with those forward looking projects and build off the work that our colleagues have been doing at the utility for quite a while.

To kind of give you maybe a bit of a crude example, if this was one book, I'd view the climate -- you know, this climate change analysis as sort of an addendum right now. What we hope to do, after we complete this, is to have it be its own chapter at the utilities.

So, additional outreach we've done. You know, during this process we have tried to identify partnership opportunities in community outreach. That includes the MC4, which is the Mediterranean Cities Climate Change Collaborative. It's a member of LARK and that kind of gives us access to the ARCCA work that's been ongoing.

Skipping along to try to really just discuss

some of the scenarios, models and data used, we focused on -- and I could get into the reasons why. IBCC Emission Scenario A2 and Global Circulation Model CCSM3, and that's housed and kind of kept up by the -- I believe it's the -- let me check -- National Center, yeah, for Atmospheric Research. I already mentioned the time slices.

What we tried to do there, and I think you heard that global circulation model described a little bit earlier, on one of the previous presentation, it's kind of like the average model. You know, it's not the hotter/drier, the hotter/wetter, it's kind of about in the middle.

We focused on IPCC Emission Scenario A2, because that's a higher emissions scenario where the impacts, you can imagine, would be slightly more exaggerated.

This does put us in the kind of precarious position of picking an emissions scenario and global circulation model to work with. And we basically set this whole system up to be iterative. Where we've created this climate adaptation planning tool. If Cal-Adapt, when it does get updated and there are new datasets available, we could upload those at night, 5:00 p.m. in the evening, things will be ready for us with additional readouts at 8:00 a.m. the next day.

This is an example of the spatial analysis. So, what you do is when you take all of our owned infrastructure and, of course, we've cleaved a lot of the infrastructure out of here so you can actually see what's going on. Black lines, transmission. The red dot in the middle is Mesa Substation. I'll be kind of using that as a reference point through the rest of my examples. What you get, this is a time slice for August, the maximum temp, and you can see right along the right-hand side there -- I probably should stay by the mic. But right along the right-hand side you see a little readout for Mesa Substation.

This, if we kind of keep hopping along, doesn't really tell you very much. But when you start looking at the effect over time, keeping that same Mesa Substation as a point of reference, you can see that there's, you know, quite a bit of additional warming that's happening in the west.

This moves from 2030, 2050 and 2085 at the bottom. Too hard to see, but I could walk you through in a bit.

I am red and green colorblind, so I don't like those maps very much. I prefer my data like this, in gray, and black and white, where it's a little bit easier for me to read.

On the left, you can basically see all of the risks which we analyzed. Those correspond to Cal-Adapt data layers. The time slices which we took, 2030, 2050, 2085, and this is all a readout for that Mesa Substation. We have this table for every large piece of infrastructure we looked at.

This will help us dramatically. It's a bit of a data dump, it's a lot of stuff, but this will help us. Because what we can start to work through is we can understand the delta. Where things will change the most and this is kind of the second layer of prioritization, where we can focus on where it seems that our infrastructure may not be as prepared for the threats that it may face in the future.

I think I'm kind of wrapping up here. So, I'll kind of go through this fast. Key climate trends in Southern California. We've heard a lot on this from other presenters. Population centers in Southern California to warm significantly.

This is actually -- the way we tried to focus this is we did our own analysis, using the Cal-Adapt datasets, and also tried to reach out to the literature. You know, you've got Alex Hall and the guys at UCLA doing really great work down there, so we tried to leverage some of that as well.

Lots of increase in extreme heat days in our service territory, especially even in San Gabriel Valley. The geography of wildfire risk is changing.

This was one of the weird ones. There are some places where there's historically been kind of a higher risk of wildfire. But if you look in the way out years, like about 2085, in some instances that actually drops down, it decreases. Some people think it's vegetation migration or, you know, other things. Basically, things aren't growing there or living there anymore.

But it just brings up this interesting point that sometimes you get these data readouts and it's all wonderful, but you have to actually start engaging with a wider set of experts to understand why that's happening and what you can do to mitigate it.

Moving forward we are planning to further refine our Climate Impact Analysis. That will include, when Cal-Adapt finalizes the updates, we'll be running those additional data layers. We're going to address a number of the issues raised by the PUC Guidance Document that Kristin mentioned earlier.

We're also trying to incorporate some of the best practices from DOE partners. I think one of the key ones will be really trying to get our head around the probabilities of extreme events. That's something

that's not really in the Cal-Adapt dataset. But I think we can -- we've learned quite a bit in our meetings with Dr. Zamuda, so we hope to augment what we've done and make it a little bit better.

Internally we have, you know, we're basically presenting our findings and we've been doing this for quite a while. Gathering the kind of physical and operational mitigation options and cost estimates from our internal folks. I've kind of mentioned the work with external stakeholders.

I'll wrap up here. When we feel we're on track to meet the DOE requirements in November. But, frankly, I think this is a work that's going to continue for quite a while and we look forward to that.

Early lessons, real quick. We feel like there's already substantial resiliency built into our infrastructure. I think that's something you've heard from some of the other panelists today. But that's not to say that these longer term impacts that are going to require some changes on our part.

Some of the threat types like wildfire, extreme heat events, drought, I thought Barry did a good job explaining how it's kind of fitting into an all hazards approach that's pretty much existing in many utilities today. And we think that that can be expanded to

include some of this climate data.

We need clear and consensus driven climate impact analysis tools. I think Cal-Adapt does a good job and, frankly, it could help a lot of the folks that don't have a large human resources and computational resources to devote to something like this, to get their head around what the impacts may be pretty quick.

There are a few remaining data hurdles. Spatial averaging, I think there's some questions we have that we're going to be reaching out to many of the experts on, some in this room. And, hopefully, we can continue the conversation and come up with some best practices to address all that stuff in phase two of the DOE work.

That is it. Thanks.

MS. RAITT: Thank you very much, Adam.

So, next is Brian -- I'm sorry, I'm probably going to say your name all wrong.

MR. D'AGOSTINO: D'Agostino.

MS. RAITT: D'Agostino, thank you, from San Diego Gas & Electric.

MR. D'AGOSTINO: Perfect, thank you very much. And good afternoon. I appreciate the opportunity to be here to give a little bit of an overview of what we are doing, now, at SDG&E to address this.

The role I play, I manage the Meteorology

Program at SDG&E, which is within Emergency Management. And a lot of the work, as we heard earlier from Cal-OES, a lot of the work that we're doing in this area exists within our Emergency Management group now, but it is expanding out.

With that regard, we really feel that preparedness is a big part of resilience. So you'll notice there the Weather Ready Nation Ambassador. We do have that, that title. We're also, the National Weather Service sees us as a storm-ready organization. And these are things that we think are a very important first step and foundation in terms of climate adaptation.

We're going to talk a bit about our wildfire resilience, and then I'd like to talk about our ICF Project, which we heard a bit this morning, which we're working on.

And then, I'll finish up, we've heard a bit about enterprise risk, and that is a very large part of how SDG&E envisions this integrating into our core business. So, I want to give some more details on how we are approaching that right now.

As we've heard over and over today, right now climate adaptation it's real, and it's happening. And for us, in San Diego, we first saw the Cedar Fire in

2003. And then, of course, 2007. The map you're seeing here is all the areas in our county that have burned since. And right now there's an active fire. I just got a report it's at 6,019 acres in the southeast portion of this map, which is not currently lit up. But we'll have to update the map come tomorrow. So, we are looking at, again, a very active wildfire.

So since, really, over the last decade we've been working very hard at becoming more resilient to wildfire.

I think how I want to start this is we go through every year and we look really closely at our Community Fire Safety Plan. And all the things that we do to be resilient for wildfire. And the list we were going through yesterday had 84 different actions that are taken. And then if you break that up, some are with emergency management, some are with operations, some are with our aviation group, and so on. So, that true decade-long embedded resilience crosses the whole organization.

But we break it up. A way that we organize it for us is -- and it's the 2014 definition of climate resilience at the UN Climate Summit. It's the ability to anticipate, prepare, react and recover from these natural disasters while minimizing the impact on our

customers and society.

So, out of these 84 things that we do a lot of them fit in, okay, is this what we're doing to anticipate? Is this what we're doing to prepare? Is this helping us react? Or, is this helping us recover?

So, part of -- I've taken just a few of those 84. But to anticipate it, we've developed a Meteorology Group. We've developed a new way to rate the fire potential every single day. It's called the Fire Potential Index. It's actually moved beyond the walls of the utility and now San Diego Fire and Rescue sends it to all 1,200 of their firefighters every day because it's become such an effective situational awareness tool.

We've build the largest utility weather network in the United States and probably the world, where we've just crossed over 170 weather stations, monitoring conditions on our network.

In terms of preparing, we've modified emergency operations. We've modified day-to-day operations with our reclosing policies and installation of IntelliRupters, and other sophisticated switches on the system. We stage crews. We collaborate with the community. We are a member of the San Diego Climate Collaborative. We'll meeting tomorrow in San Diego.

The Fire Coordination staff has been hired, so we've actually built up, we have six fire coordinators. So, an example of that was yesterday, as a fire was threatening the 500 KV line, along the Mexico border, we had fire coordinators working directly with the incident commanders on the fire, which is part of that level of collaboration that we need.

And then, of course, I think the wildfire has -- we're so far into that that there is a full hardening project. We are a full wood to steel on the transmission system. And we are looking at a full hardening of all of the backcountry of San Diego. It's a FIRM project, fire risk mitigation, where we're going wood to steel and hardening the entire distribution system. It's a decade-long project. This year, we spent over $80 million on that. And that's going to be a continued investment until the project is done.

But what we have found is I wanted to discuss here some of the tools and things that I heard earlier today. One that resonated was how do we turn some of this climate data into an operational tool that we can make decisions with?

The Santa Ana Wildfire Threat Index is an example of that. It's an hourly climatology. We heard about dynamical downscaling earlier. There's 28

terabytes of data behind that graph, up at the top. But what it is, is it takes that and it converts it into the fire potential today is moderate, it's high, it's extreme, so that the decision makers can actually look at it. Because if we see a heat wave coming and we say, yes, there's a heat wave coming, we need to know if it's a category 1, 3 or 5 so that we can actually, as a utility, respond appropriately.

I know just a couple years after we really got into wildfire resilience, we would find that we would take very large responses to events that were marginal. So, making sure that we could react to these events in a reasonable manner was important.

The other thing that I wanted to mention here is when you're spending a decade to rebuilt your entire backcountry, you need to find a way to prioritize what goes first. And, really, how do you bring that type of intel in? I mean, and you really need to assess the magnitude and the probability of impacts. And I know that's something we're doing with Craig, with the DOE.

With wildfire it's difficult. But what it's taken is really state of the art wildfire modeling, where we go in and do 1,800 simulations of every possible wildfire ignition point that we have in San Diego. So, they are 70 million wildfire simulations

later, we have a risk portfolio where we can start prioritizing what gets hardened first, and how do we minimize our risk the most by hardening certain events -- or pardon me, certain assets. So, that's our wildfire risk model.

A lot of the lessons that we have learned from wildfire we are now expanding into our project with ICF. And thank you, we have two projects right now with the Energy Commission. One is to look at sea level rise impacts along the San Diego coastline, and come up with adaptation alternatives.

The other one that we're looking at looks at all impacts to our gas system. But we're really treating it as one project.

So, part of the screen, what you're looking at here, the image on the right is actually a map showing the sea level rise from the most recent CoSMoS, which was released for San Diego in December. And from there, down on the bottom, it's actually that very up to date cliff erosion maps, where we can start overlaying it. So, we're really starting to understand, you know, some of the latest science and integrating it onto the system.

And part of what this does is when we're looking to identify and prioritize our vulnerabilities, develop

the inventory of assets, it's this GIS project where we have all that data. It's all compiled and ICF is now working to get all of this prioritized for us.

I'll speak briefly to the map on the left, for those of you in the back that can't read some of it. But the areas in red are known landslide areas. The areas in yellow are areas that we're saying the formations are prone to landslides. So now, we're looking at the resiliency of our gas system and all those assets that are in there we'll have to come up with some mitigation strategy to deal with the potential climate impacts in that area.

So, this is where we're at with this project. Task 2 of our ICF project has been to develop a very comprehensive vulnerability report for both our gas system and our electric system. We did a high level vulnerability report for Dr. Zamuda and the DOE. And there's a lot of the additional detail is in our ICF Vulnerability Report, which will be -- it's in the final stages of completion now and we'll be updating that here, soon.

As we look at Task 3, part of that is what you're seeing on the map here behind us. It's that in-depth, asset-by-asset piece there.

I know, for time's sake, I'm going to move on

because this is something that I want to talk about. How are we going to take this information and get it into the core business?

So, we've heard here, from multiple groups, about enterprise risk. In 2015, climate adaptation was added to Sempra Energy's Enterprise Risk. The organization has, you know, over 40 risks and climate adaptation was one of them.

Well, we came to the point when we really started analyzing the risks and we did the vulnerability report, we realized that climate can't be a risk on its own, or it can be a risk on its own, but it touches so many of those other risks.

So, we did an internal study within SDG&E, where we cross-referenced the reports that we've done with ICF and the reports that we've done with the DOE to our preexisting risk registry. And then from there, you'll notice these risks.

These are the risks that SDG&E currently has in its registry, where we've added climate as a component to that enterprise risk. So an example, wildfires of course, with the change in drought and patterns. We've always focused on the fall, where now we are having 6,000-acre fires in June. We had May fires in 2014. Climate is impacting that. So that, all that

information gets integrated into the wildfire risk.

Natural gas supply gets addressed here. But then even as we get into some of the additional specific actions, this even gets into emergency spares is an enterprise risk for the organization. So, then that's the way that we get in and start making action with this is that we add a climate component to the emergency spares risk, if that makes sense.

Right now, SDG&E is planning their RAMP risk for filing for the next GRC. We have a vulnerability matrix of all of our risks to see which ones escalate to the point that they'll be included in the RAMP risk. And out of that, the ones you see with the asterisks there, those are the ones that have been escalated to that next level and will be part of our RAMP filing.

Electric infrastructure integrity is the parent risk for sea level rise. Gas distribution. As we start looking at different loads and other things.

For the interest of everybody's time, I want to give us plenty of time for questions, so I'll end it there. Thank you.

MS. RANDOLPH: I actually have a question about the one red thing you didn't mention, which is DERS. And I wanted to get a sense from folks how they're dealing with non-utility owned generation assets and how

you're dealing with the risk to your system and climate change, et cetera.

MR. D'AGOSTINO: So, what we have particularly working at with this is the stuff that we own and is within our service territory. There have been discussions that the additional monsoonal heat and other things pose a threat to all of our centralized generation. Out over the deserts, the areas even more prone to the monsoon than we are.

But other than that, what we have found is out of that whole list, part of the reason that the distributed energy resource hasn't been mentioned so much with climate is that there's not a really evident, right now, large impact to the San Diego area. I don't want to speak for everybody else. But not a huge climate impact on that, that we're detecting right now.

MS. RANDOLPH: Did anybody else want to talk about distributed energy resources?

MR. SMITH: Yeah, I'll mention it. So, when we talk about climate change it's -- you know, that's not falling high in our risk ranking, just because of the reserve margins, you know, power in the State right now. But that's something that could change over time.

And if you take a look at the geospatial view of where those resources are, they don't really touch

places where you have the sea level rise and other areas, you know, because it's more of the urban areas, and most of these facilities are located more in the interior.

MS. RANDOLPH: Okay, that's helpful to know.

MR. TUTT: I guess what I'd say is that SMUD's nearly finished with a comprehensive distributed energy resource set of strategies, looking at not only photovoltaics on our customers, but also our own, and electric vehicles, and demand response and coming up with implementation strategies. Which we're not final, yet. I don't have them to give to you.

But I would mention, distributed energy resources in this context, in two ways. One is the resiliency issue that I mentioned before, identifying areas that are important in time of a disaster to have continued power with solar plus storage is something that I think we'll be looking into in the future, and with our local governments in collaboration and partnership.

And then the second is I know that a lot of people -- the urban heat island or the urban -- the heat wave effect of climate change. One of the issues we see is that that can affect our distribution infrastructure, our transformers and so on that can get overloaded. Not

only from the heat in the afternoon of a hot day, but also just the heat of the load covering all the air conditioning.

And while distributed energy resources typically don't provide power directly when the system load is at its highest, what they can do is reduce the load on those transformers and the distribution lines in the afternoon, as the heat is building up. And that allows them a little bit more room to be resilient when the peak hits.

MS. RANDOLPH: Okay, and I will say -- and I'll just make a quick comment that will kind of double as my closing comment, and then I'll turn it over to my fellow panelists for questions. Which is I was glad to hear that you guys are starting to work on those overlays. You know, the overlay between the data and the physical system, and trying to identify those gaps. And so, that was really good to see and looking forward to more detail on that.

COMMISSIONER DOUGLAS: And, you know, I'll just add that I'm also really glad to see the work on the overlays, the geospatial work, the work with some of the tools like Cal-Adapt.

I guess I'll ask one question and then we should probably let our moderator ask one question, and then

maybe wrap up. And turn to public comment, I should say. So, if anyone here would like to make a public comment, you're about to have your chance.

My question is, you know, as you, as utilities, proceed to work on climate adaptation, and consider risks, to try to incorporate those risks into the way you handle risk management or other operations, you know, what are some of the best ways that the State can be of assistance in simplifying, or providing guidance, or anything else? You know, how can the State be most helpful in this area, from your perspective.

MR. ANDERSON: I'm happy to at least maybe start. I think the convening power of the State agencies -- you know, they can collectively bring a lot of people to the table. And when we're talking about understanding the vulnerabilities of assets which we don't own, but we rely upon, it's a very interconnected grid, of course, and the power market is big and looking like it's going to get bigger. Bringing those people to the table, to understand their vulnerabilities, how they're going about assessing them and what they may be doing to adapt or mitigate those threats would be very helpful.

You know, we can all do it individually. SDG&E can go talk, I can go talk, PG&E, you know, SMUD, all

the other guys, we could all go up there and talk with them individually, or we could kind of do it together. And I think there may be some efficiencies in doing it together.

COMMISSIONER DOUGLAS: Thank you. Other thoughts on this?

Nancy?

MS. SUTLEY: You know, I think along the lines of data and tools, we're already doing a lot of that. But, you know, we don't have science or research capability in a lot of these areas. And so, being able to get that kind of information and have it also in the form of not just raw data, but also tools.

I guess the one other thing I'd just mention is we're sort of getting bombarded with requests for our data for various -- you know, people wanting to run scenarios and look at it. And that starts to be a challenge from both a data privacy, as well as just a kind of workload thing. And so, I think to the extent the State can help us, help everybody sort of shape the questions and the kinds of information that's, you know, valuable, that helps us as well.

COMMISSIONER DOUGLAS: Thank you. Other thoughts?

MR. D'AGOSTINO: Just one last thought. I've

found that as we're developing our sea level rise thresholds we've been working very closely with the communities through the Climate Collaborative. And I know we're already in the process of doing it. But almost continuing that we do it on a statewide. I know we had that conversation this morning, with Guido. But really, make it, hopefully, creating that environment that we're not only doing it regionally, with the cities, but then we're also doing it utility-to-utility, and northern part of the State to southern part of the State, if it makes sense.

COMMISSIONER DOUGLAS: It does, thank you.

And I think I'm going to just throw another question in there. So, you know, as utilities, you're all really kind of in the thick of climate adaptation, in the sense of having to deliver services, and run -- not always large, but run organizations. And at the same time interface with and manage, with varying levels of resources that you're able to dedicate to it, but manage the science, interface with the science, apply it, and also interface on policy side in terms of being at least part of the policy debate of what the right steps are going forward, and how that should happen.

Do you have any thoughts about some of the conversation earlier in the day, about how we can more

effectively bring together the science and research? Not just agenda, but information into the realm of implementation?

MR. SMITH: Yeah, I'll take a crack at that one, first. To me, it would try to try to anchor ourselves on what are the most likely scenarios to work on. You know, when you're trying to solve for a problem that's that wide, I think that would help. And I know it's kind of a gray area.

But I think as we all work together, you know, we're depending on one another for mutual aid. We're depending on one another for emergency equipment and things like that. And I think if we anchor on certain scenarios that we'll all be prepared to help one another out, as well.

COMMISSIONER DOUGLAS: Scott?

MR. TOMASHEFSKY: One thing that came to mind, and during the height of the PIER Program you always had your annual assessments, where you had several days of discussions in terms of research.

If you did something similar to that, in terms of here's adaptation strategies, so that you're bringing that in some sort of symposium type of way, where you're sharing information and research that can then be filtered down to the various regional entities that are

looking at some of these issues on the ground. It allows you to do some of that work that really would not be done at that level, and then they can rely on that. And then you do have the ability to deal with some of the consistency of looking at a statewide approach towards things.

And then, you can kind of customize it as you deal with the issues. But it's a perfect opportunity to do that type of work.

COMMISSIONER DOUGLAS: That's a really interesting idea and it does help connect to experiences on the ground and regional collaboratives.

And I noticed, I didn't remark on it, but PG&E's grant program, that you're rolling out to provide assistance to some of the local efforts I think is a very helpful step.

Tim, were you reaching for the mic? Go ahead.

MR. TUTT: Yeah, I guess what I was going to add is the standard answer in cases where there's a lot of uncertainty and a long time frame out in the future seems to be to be try to identify no regret strategies. Things that you -- you know, you don't know what the future's going to hold, but if you do this it's going to be good in a variety of different scenarios.

I guess one example would be we know that with

increased heat there's going to be a -- maybe a 7 percent reduction in our generation potential from our natural gas-fired power plants in 2050, 2080, whatever.

Well, that's beyond the useful life of those assets. So, is it -- how do we handle the question of dealing with that impact when the asset might not even be there anymore.

COMMISSIONER DOUGLAS: Thanks.

Dr. Zamuda, one burning question, if you would like?

DR. ZAMUDA: In appreciation for the expert question to ask, and I respect the clock of the agenda, I won't bore you with additional questions. I'll simply acknowledge a job well done. It's a job that's evolving as you move forward. There's always continuous improvement. But I think the panel has demonstrated the excellent position today and to build upon that as we move forward.

COMMISSIONER DOUGLAS: Great. Well, thank you for that comment. Thanks for your help with this panel.

And I'm just checking, anymore questions?

Well, really appreciate both your work in this area and your participation here today. I know we got a lot out of hearing what you had to say and appreciate it. And so with that, thank you very much.

And let me now turn to public comment. Heather, do we have blue cards out?

MS. RAITT: There are blue cards, but I didn't receive any.

COMMISSIONER DOUGLAS: All right. Well, if you are here and would like to make public comment, whether or not you filled out a blue card, this is your moment. Please come forward, just stand up and come up to the podium, if you'd like. Please.

MS. HAYWOOD: Apologies that I missed the blue card memo. I will keep it short. I have three minutes here. I just wanted to give a quick perspective from the New Technology basis. I know we talked a little bit about some clean tech innovation topics. And a little bit on what we believe is the importance of leverage, of using with the resulting process moving forward, after these IEPR conversations, specifically on using grant money in different programs, whether at the CEC, DWR, DOE, and other entities for leveraging private capital. Specifically, to help scale up very important technology innovations that will help address a lot of the issues that we discussed today.

COMMISSIONER DOUGLAS: Okay, and I'm sorry. As maybe you were about to say, but if you could identify yourself and any affiliation for the record, please?

MS. HARWOOD: So, my name's Meghan Harwood and I'm with Natel Energy. And we are a low head distributed hydropower company, based out of Alameda, in the Bay Area. So, we manufacture a new type of low head, fish-friendly, hydropower turbine. And here, in California, we are focusing explicitly on -- as our first market on drops in existing irrigation infrastructure.

And so, some of our climate resilience work has focused on specifically pairing some of the projects that we're pursing here, and with irrigation districts, with other climate resilience, both water management, as well as grid services strategies. So, that has included talking with a couple of districts in the Central Valley on pairing projects that are -- you know, that are generating new baseload renewable energy generation that's distributed, low head, and flexible over time. Unlike conventional hydropower has been, as we've seen. With projects that are focusing on water management strategy, such as diversion of winter flows for groundwater recharge, or flood mitigation purposes, as well as explicitly pairing our projects with more intermittent sources. Specifically with solar, where we can provide flexible -- where we can provide innovation on the control side for flexible dispatch, to help firm

some of those -- to help firm intermittent sources. And if you're delivering at the interconnection point, provide a higher quality grid service.

And so on that note, I just wanted to highlight the important moving forward with these conversations on creating a framework for programs that can help mobilize private investment. So, we've been pretty active in some of the CEC, some of the EPIC programs, specifically grant programs, as well as some of -- we've kind of been in the loop and keeping track of some of the DWR water energy grant programs. And have been very involved with DOE programs in the past.

And we think that it's very important that in order to achieve the scale that's necessary for the urgency in the short term, immediate urgency of delivering on some of these solutions that pursuing grant programs, focus not just -- I mean, we have benefitted a lot from some of the R&D focused programming. And there's a lot of data that's very important for us and for other entities. But that they also focus on kind of piloting and early commercialization programs that allow early stage technologies to prove out their technology in a state, and then scale from there and then really deliver on that necessary scale. So, that's just a quick

perspective.

COMMISSIONER DOUGLAS: Thank you for your comments.

Other people with public comments in the room?

All right, let's turn to the WebEx.

MS. RAITT: I don't think we have anything on WebEx.

COMMISSIONER DOUGLAS: Okay, great. And nothing on the phone lines?

MS. RAITT: Yeah, so we will open up the phone lines. If you're on the phone, please mute the line unless you'd like to make comments.

Okay, I think that's it.

COMMISSIONER DOUGLAS: All right. Well, I'd like to thank everyone for hanging in there with us through a long day. And we're adjourned.

(Thereupon, the Workshop was adjourned at 5:01 p.m.)

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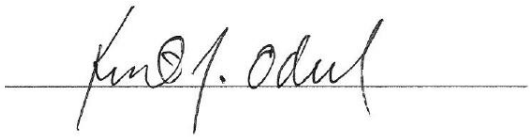

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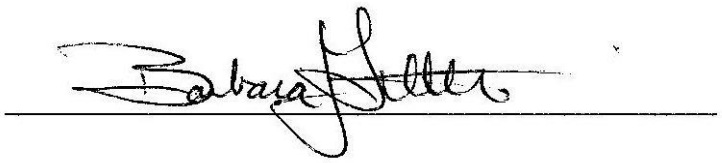

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