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CALIFORNIA ENERGY COMMISSION

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Climate Adaptation and Resiliency

CALIFORNIA ENERGY COMMISSION

ROSENFELD HEARING ROOM – FIRST FLOOR

1516 NINTH STREET

SACRAMENTO, CALIFORNIA

TUESDAY, AUGUST 29, 2017

10:00 A.M.

Reported by:

Gigi Lastra

APPEARANCES

COMMISSIONERS

Robert Weisenmiller, Chair, California Energy Commission

Karen Douglas, Commissioner, California Energy Commission

Janea Scott, Commissioner, California Energy Commission

Liane Randolph, California Public Utilities Commission

Cliff Rechtschaffen, California Public Utilities Commission

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David Stoms, California Energy Commission

Scott Flint, California Energy Commission

Susan Wilhelm, California Energy Commission

Guido Franco, California Energy Commission

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Pam Doughman, California Energy Commission

PRESENTERS

Jamie Anderson, California Department of Water Resources/Natural Resources Agency

Jamie Anderson, CA Department of Water Resources/Natural Resources Agency,

Brian D'Agostino, San Diego Gas and Electric

Scott Tomashefsky, Northern California Power Agency

APPEARANCES

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Nancy Sutley, Los Angeles Department of Water and Power

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Francesco Avanzi, University of California, Berkeley and Merced

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Louise Bedsworth, Governor's Office of Planning and Research

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Alan Sanstad, Lawrence Berkeley National Laboratories

Geoff Danker, Southern California Gas Company

PUBLIC COMMENT

Kathleen Ave, SMUD

AGENDA

AGENDA

P R O C E E D I N G S

10:03 A.M.

SACRAMENTO, CALIFORNIA, TUESDAY, AUGUST 29, 2017

MS. RAITT: Good morning everybody. We're going to go ahead and get started. Welcome to today's 2017 IEPR Workshop, a Joint Agency Workshop on Climate Adaptation and Resiliency for the Energy System.

Just a few of the regular housekeeping items.

We are being recorded through our WebEx conferencing system. So the meeting will be recorded and recording of the meeting will be posted in about a week, and a written transcript in about a month.

We do have a very full agenda, so I'd like to remind our panelists to please stay within your allotted times. And we'll be giving you a little notice, when you have two minutes and when your time is up, and so I thank you in advance for sticking to your times.

At the end of the day, we will have an opportunity for public comment. We'll be limiting those to three minutes per person. And

at the end of the day, we'll, also, we'll be taking comments, first from those in the audience, and then WebEx participants can use the chat function to let us know that you have a comment, and then we'll open the lines.

Written comments are welcome. They're due on September 12th. Materials for the meeting are posted on our website and available in hard copy at the entrance to the hearing room. And the notice has all the information for submitting comments.

So with that, I'll turn it over to the Commissioners for opening remarks.

CHAIR WEISENMILLER: Thanks Heather.

I'd like to thank everyone for being here today. Obviously, adaptation is a very important topic. You know, as we all look at the tragedy in Houston, it's unclear how much of that is the result of climate change and how much of that is the 50-year flood, but it's certainly a reminder to all of us that things can go wrong here pretty seriously in these areas. And it's important that we think for our infrastructure, particularly our critical infrastructure, how to be prepared.

So anyway, looking forward to a great session today.

COMMISSIONER RANDOLPH: I'll just, once again, thank the CEC for hosting the workshop. And as Chairman Weisenmiller said, you know, the events of this week are important reminders of the vulnerability of our infrastructure. So I look forward to our discussion today.

COMMISSIONER RECHTSCHAFFEN: Boy, that's challenging to be as brief as these guys. That's very impressive. My goodness. Well, I'll be extremely brief. I'll be a little less brief.

Obviously, as we know, the impacts of climate change are here. And it's incumbent on our energy utilities to prepare for those impacts.

My role at the PUC, I just wanted to highlight some proceedings that we're involved in, which really are crosscutting and first in the nation.

We have two proceedings where we're really making the utilities prepare for dealing with the impacts of climate change. One is the Safety Model Assessment proceeding where we asked the utilities to evaluate all the risks, safety,

physical infrastructure, and otherwise what they're facing, and those include climate change, and increasingly, we have to include climate change, and then asked them evaluate how they're prioritizing those risks and mitigating them.

And when we have a separate proceeding that deals with how utilities spend their money, which, of course, is very, very important. And as part of our general rate case, we have a risk assessment and mitigation phase where we evaluate how they're spending their money on the risks of climate change that they've identified. We're still in the early stages of this process, which is why workshops, like this, are so very important because collectively, and for the energy utilities in particularly, we still don't know exactly the best way to evaluate risks, what the extent and scale is, and how to best spend money to deal with them.

So those processes are going to be ongoing, informed by the best science. And I look forward to today's discussions.

COMMISSIONER SCOTT: Good morning everyone, and thank you for joining us. I'm also very much looking forward to today's discussions.

I think back to when I first out of school and working at Environment Defense Fund. And we heard from the International Panel on Climate Change, that we would be seeing things like -- that climate change could cause things like more days over 90 in the summer, that it could cause stronger storms, and many other things that I actually feel like we are starting to experience now. And so I can't really understate the -- or overstate the importance of today's discussion and thinking about climate resilience. And I'm looking forward to learning a lot this morning, so thank you very much.

MS. RAITT: Great. So our first panel is on how California's Fourth Climate Change Assessment and other efforts are informing climate adaptation for the energy sector. And David Stoms from the Energy Commission is the moderator.

MR. STOMS: Thank you, Heather, and good morning everyone.

So our first session is on -- or panel is going to be on the Fourth Assessment, California's Fourth Climate Change Assessment, and other sort of related efforts to inform

planning efforts for resilience. And we'll sort of start with several state agency folks talking about some of the tools that have been developed. And then we'll switch to a representative from one of the IOUs, and then to someone from the public utility side, to talk about how they're using some of these tools, the kind of planning they're doing or thinking about doing.

So our first speaker will be Scott Flint, who will talk about one of those tools, the Climate Console.

(Off mike colloquy.)

MR. FLINT: Thank you, David.

Good morning, Commissioners and workshop participants. I want to -- this morning, I want to give you brief look at the California Climate Console. It is a climate tool that was developed, starting for the Desert Renewable Energy Conservation planning efforts, and has been expanded statewide. Its primary focus is to help look at and visualize how climate change may occur across large landscapes, and how you can use the climate information to inform various decision making during planning, whether it's planning for conservation, planning for renewable

energy siting, fighting both for generation and for transmission. So we'll just take a quick look at that, and it will give you a couple of examples of how you can actually use information from the console and other information to get some insight into a couple siting issues.

So we're viewing the Climate Console live. The Climate Console is housed with Conservation Biology Institute, who has been working with us on major planning efforts across the state. I'm just going to talk briefly about some of the data layers in here, but not a lot. I want to get to the examples.

So first of all, to use the Console, there is lots of information and tutorials here. If you jump on the website, which is at the back of your handout, where to go directly to the website and get on the Console, you'll start here. And you can explore these tools, and it will give you some idea about how to use and navigate, or just jump in and start playing.

We do have a couple ways to -- reporting units that you can select to look at information, or you can draw your own area of whatever size of shape that you want in the Console. Once you

select an area in the Console, you'll see on this side of the screen, on the right side, that's changed, and you have some information from the climate models that are included here. We have ten climate models that are featured in the Climate Console. They're the same set of models that the state has focused on looking at for the Fourth Assessment purposes and other work in California, so we have those here.

Across here you can pick what you want to look at, or a variety of models here along the bottom. Up here in the I button, you can see all the detail you want about those models, where they came from, how they were downscaled, their resolution, how they compare to each other, and how the variables were calculated in the Climate Console.

So getting that quick look, we also often frame things for a purpose of our work and our planning work into assessing things amongst these four climate models to look at the four corners of potential change. So I'm talking about a warm-wet model, a warm-dry model, a hot-wet model and a hot-dry model, so those are featured here also.

So I've picked Fresno County. And when I do that, what I see here is the maximum temperature. I'm going to pick the hot-dry model, something I want to look at. You see the maximum temperature for the hot-dry model historical value and the projected climate values for this model over two 30-year periods, 2016 to 2045 and 2046 to 2075. So there we have that, just for max temp.

Down here we have a summary of what else is going on there. We have a summary of max temperature, average minimum temperature, precipitation, aridity, potential evapotranspiration. So we picked those variables to look at because they're particularly important in influencing vegetation on the landscape, and therefore the habitats that will be on the large landscape.

There's also a tab here that looks at a couple of models -- indices that we put together, one for climate exposure and one for site sensitivity. So you can click those and the model will come on here, and you can explore those sorts of models too.

And one more tab. For climate impacts we

have the models that -- the four models that -- the four corner models running with the vegetation modeling so we can look at potential change over time in the vegetation. This is animated and you can run it, if you want to watch the change over time.

And you can also explore a few key things related to carbon, fire and water going down here with these tabs.

So how is this information useful?

So back at -- in planning efforts or in siting renewable energy projects and transmission infrastructure, we go back to the hot-wet model on this page, click here. So here the tool is particularly good at visualizing what might occur as the climate changes in these different variables that we've looked at. And we have all of those -- quite a few here. We're not -- we don't just have temperature, but we're looking at temperature for now in the example.

So one thing you can do here, once you went through the scenarios and decided on what climate variability you want to look at, you can quickly -- you can press this button and quickly export into the main database and platform, which

is where we have been compiling and posting most of our information from the various planning effort that we've been putting together. So you can quickly take that particular climate model and scenario that you were looking at into database and add other datasets to help you interpret what's going on there.

So if this were a training video, this would be the part where, you know, you just jump over to the map which is already done, which I'm going to do here.

So I have a map here, and we're looking at an area in the San Joaquin Valley. And so earlier the Energy Commission did a siting effort in the San Joaquin Valley to identify lower-conflict areas for potential renewable energy development, solar PV development in the Central Valley. And in that assessment, we looked at quite a few environmental models, but we didn't really look at climate. So now we can go back to the results of that and we can add climate to our thinking.

And so we first -- first, what we can do from the Climate Console is look at what's going on with that maximum annual temperature in this

area. So what I have highlighted here are parts of the Westlands Water District which, through our work, we found out would be a place that, because of various impairments, is not, probably, long-term viable to remain in ag, so that's the large area in red.

Here we're looking at the temperature results from the modeling and we're seeing that there are -- while there's variation across the county, we're in western Fresno, we see different degrees of temperature change, even at this scale, across the county. We see this area getting very hot.

What's going on here is an increase of about seven degrees Fahrenheit over the next 60 years, that's showing up in the red, and we have some differences in that. As far as mean projected precipitation, we brought that over and can look at that too. We have a large decrease of precipitation in this area. And those two things combine to also give us reductions -- some aridity increase here of 32 percent, and evapotranspiration increase of 12 percent over time. So combining that sort of water deficit data with some other data that we've looked at

here, we can look at lands that show a combination of land status and water stress, and so it looks like this. And now I'm reconstituting that to just show high value ag lands that show a high to moderate level of water stress due to climate change in this area over time.

So if we're looking for areas to site for renewables here, we, in our earlier exercise, without taking climate into -- climate change into effect, we kind of missed a few areas here. And so other areas that are showing up as this high water stress are here in orange, that are now prime farm land but in the long term probably will not remain so.

We can also combine other lines of evidence to show -- to kind of figure out what's going on there and what climate might do. We can look at -- in this particular area, we will look at, I'll just quickly show you, fallowed ag land during the drought, so we'll take a look at that. Again, west of this area in Westlands, we see a little bit of fallowed land, annual -- from an annual dataset in 2011. And after the height of the drought in 2015, we see a lot more area that

is now fallow here west of the site.

So this gives us some insight, bringing in climate into the equation about where we also would look to other areas that might be best suitable for considering and further studying for siting renewables in the future. Because given what's going on with the climate, the information tells us and multiple lines of evidence tell us that this area may not be long-term suitable or remain long-term suitable for agriculture. And it takes in the other water deficit sort of items that we didn't look at in our earlier study.

So that's how you can use the Climate Console. That's how you can use it specifically into looking at siting areas of infrastructure based on this example in the valley.

Thank you.

MR. STOMS: Great. Thank you, Scott.

So our next speaker will be Susan Wilhelm, who will be talking about another climate tool, Cal-Adapt and version two.

MS. WILHELM: Good morning. Today we will have a look at Cal-Adapt 2.0, which migrated from beta to primetime just last week. My talk today will answer three questions. What is Cal-

Adapt? How is being used by the research and resilience community? And how is it evolving to respond to energy sector needs? And then I'll offer a brief, live tour of the site.

I'll begin by thanking UC Berkeley's Geospatial Innovation Facility, which developed both the original Cal-Adapt and version 2.0.

I'd also like to thank our Technical Advisory Committee, which includes IOUs, SMUD, CPUC, CalISO and others. The Advisory Committee has provided a lot of useful input to us, and this is reflected on the new site.

Okay, so what is Cal-Adapt? The overarching goal of Cal-Adapt is to make scientific projections and analyses available as a basis for understanding local climate risks and resilience options. Cal-Adapt does this through a web-based platform designed to make peer-reviewed data readily available in an intuitive, easy to understand and interactive format. People have a variety of visualization tools to choose from, which you see represented by the icons at the lower part of the screen. And choosing these icons, you can then explore very site-specific, location-specific climate

projections.

I'd like to say a few words about how California utilities have used Cal-Adapt to support vulnerability assessments required by the U.S. Department of Energy's Resilience Partnership. California IOUs use Cal-Adapt as a basis of understanding what climate risks they face.

More recently, San Diego Gas and Electric has used Cal-Adapt to support on-the-ground resilience efforts, and you'll hear more about this later this morning from Brian D'Agostino. Okay.

What you're looking at here in the red box is that Cal-Adapt defaults to regionally downscaled versions of four global climate models which were systematically chosen to represent a range of possible futures. In response to IOU requests for common scenarios to use for planning purposes, last year's IEPR named these four models as a tractable subset of ten global climate models, which are all showcased in Cal-Adapt, along with two emissions trajectories. These same scenarios are also the basis for California's Fourth Climate Change Assessment,

which includes a suite of 15 energy studies to further inform energy sector adaptation.

Having state-sanctioned data is a basis for research and planning. It fulfills one of the major requests from a variety of Cal-Adapt users, who have repeatedly expressed a need for an authoritative data source.

Energy researchers involved with the Fourth Assessment are using data on Cal-Adapt for a variety of things, including analyses of energy infrastructure and operations as related to wildfire, extreme precipitation and more. As shown at the bottom of this figure, when you're choosing the location you want to investigate in Cal-Adapt, you can pull up electricity sector infrastructure. And I've pointed specifically to Transmission Paths 25 and 66 here, which are one of the areas that are being investigated with regard to wildfire risk by the Fourth Assessment. Specifically, in this general area there were 17 fires within a quarter mile of these transmission paths between year 2000 and 2016. Okay.

As a publicly available tool, Cal-Adapt has been adopted by a number of other resilience initiatives. As shown on the first bullet, the

2017 update of California's General Planning Guidelines points local governments to Cal-Adapt to support a statutorily required adaptation element of general planning. The list of uses is long. But another one I'd like to point out is the California Government Operations Agency, or Gov Ops, has leveraged Cal-Adapt's publicly available applications programming interface to develop an automated tool that supports incorporation of adaptation concerns and to sustainability roadmaps for over 1,000 facilities.

So this public API that Gov Ops used is a new feature of Cal-Adapt 2.0. The API supports third-party development of custom tools, which is critical because different people need to process data in different ways to support their particular decisions. This API renders the number and specificity of potential applications limitless. And users can find basic documentation, tutorials and examples at this website.

On September 12th, UC Berkeley's Geospatial Innovation Facility will offer a User Needs Assessment Workshop here in Sacramento. At

this workshop, you'll get a tour of Cal-Adapt 2.0. And we'll be seeking feedback on specific enhancements that Cal-Adapt could incorporate to serve the electricity sector. This is really a great opportunity to offer specific input that will shape Cal-Adapt's evolution.

Cal-Adapt will continue to evolve to reflect new research and to keep pace with emerging energy sector resilience needs.

And now I would like to transition to a live demo. Okay.

So the site is at Cal-adapt.org. And on the landing page, you'll see that there are a number of tools available. There are also data resources and some supporting information.

We're going to jump right into the extreme heat tool. When you land in this tool, you're in a grid cell in Sacramento. This is about three-and-a-half miles by three-and-a-half miles. But I'd like to change the location to a census tract in Stockton. And for this purpose I've selected the boundary selection feature that enables us to look at census tracts with their CalEnviroScreen score. So the red census tracts here represent high scores on CalEnviroScreen,

which translate to disadvantaged communities.

So I just transitioned to a business as usual, high emissions scenario. And on the fly, Cal-Adapt created this visualization from daily time series of maximum temperature. On the gray line you see historical observed number of days above a threshold that is locally defined to be relevant to this area as 102 degrees. And the historical period, as you see with this slider widget, we had about four of these days per year. Moving forward in time, all four of these projections project a huge increase. And we can expect about an order of magnitude more very hot days in this census tract by the final three decades of the century.

As you scroll down you see that you have, you know, the ability to easily change your model selection.

And scrolling down further, you see that we can also look at the timing and magnitude of these very hot days. On the Y axis, we have the months of the warm season, April through October. And we see that historically, in the 1960 to 1990 period, these dots, which represent extreme heat days, are confined to early June through mid-

September. Moving forward, the season for hot days expands broadly, early May, well into late October. And you'll also see that the color of these dots changes and you see more yellow dots, which are the highest temperatures seen here, 108 to 120 degrees.

So, basically, Cal-Adapt is telling us that infrastructure planning needs to anticipate a broader hot season and a hot season that has the volume turned up quite a bit. Okay.

So the next example we will look at is precipitation. For this example, I'm going to go back to the boundary selection feature. There are a number of preloaded options which include watersheds, climate zones, counties, census tracts, congressional districts and more. We are going to look at electric utility service territories.

As many of you know, it was a rough year in Truckee Donner Public Utility District. A lot of precipitation meant a lot of service outages. And so I'd like to look at annual average precipitation for this service territory.

In the gray envelope here you're looking at the maximum and minimum of an ensemble of 32

models, all of which have data available on Cal-Adapt that have been downscaled to very fine spatial resolution. The gray line is observed historical data, and then we have four projections.

The signal may not be immediately obvious, but looking at our slider tool here, we see that relative to the historical baseline the end-of-century average for annual precip under these four models looks like it will increase by about 25 percent. More instructive is to look at individual models. And we see that some models predict pretty much no increase. Others predict about a 25 to 60-plus increase.

Another thing to note, since we're very much concerned with storms these days, is that the peak years are getting higher. That means the wet years are getting wetter, so we should be prepared for more intense storm years.

I'd like to jump to a snowpack tool now. You can look at this as an animation. But I'd like to go to a time series for a watershed of interest with regard to hydro resources. So I've selected watershed as my boundary feature. And if I type in Upper Middle Fork, we can find the

American River Watershed that's very valuable to SMUD. And we see, of course, that all four of the priority models indicate a huge decrease in April snowpack by end of century. But we may also want to know what's going to happen say midcentury, so we can move this slider tool to the 2030 to 2050 time frame and we see that even for midcentury, we're expecting about a 22 to 65 percent loss of snowpack in this watershed.

One more thing I'd like to point out that was done in response to Advisory Committee input is that you can download data directly from these charts straight into a spreadsheet for further analysis.

Cal-Adapt also showcases new wildfire simulations produced by LeRoy Westerling. These wildfire simulations are based on the LOCA 1/16th degree, very high resolution, downscaled climate data. I'm going to go to Shasta County, which is the area that we looked at earlier with regard to Transmission Paths 25 and 66. And here we see, again, that even in sort of a mid-century time frame, some of our models predict increased fire risk.

The final tool I'd like to take a peek at

looks at cooling degree days and heating degree days. Guido Franco will talk more about this later today. But this tool does provide us a basis for looking at how planning will -- may need to consider projected climate change. Because the amount of energy we use to cool our buildings is headed up. We may need less energy for heat. And I'll let Guido tell you more about that.

So the data that we've seen on these visualizations today is just a subset of what's available on Cal-Adapt. We also have sea level rise data available in two different formats, as well as a suite of hydrological variables, including relative humidity and stream flow. And there are some blog entries that can give you more information about Cal-Adapt, how 2.0 is different from the original version. You can learn a bit more about the models.

And I'd just like to close with another plug for the September 12th User Needs Assessment Workshop. We would love to hear from you and learn how we can enhance Cal-Adapt with more specificity for the electricity sector.

Thanks.

MR. STOMS: Great. Thank you, Susan. And I want to complement both you and Scott on your confidence of doing live demos. That was impressive.

So our next speaker will be Jaime Anderson from the Department of Water Resources. Susan mentioned about the energy sector projects for the Fourth Climate Assessment. And Jamie will now talk about some complementary projects being done for other sectors that overlap or complement the energy sector.

MS. ANDERSON: Thank you, David.

If you're okay with it, I'm going to talk from here. If I go stand behind that podium, we're not going to be able to see each other.

So I'm here to talk about all the other research projects for the Fourth Climate Change Assessment. But I wanted to start with kind of giving us a framework of the Fourth Climate Change Assessment. I know you've heard about it at past meetings.

And the orange boxes here are illustrating the kinds of datasets that have been developed, which I know have been discussed at these previous meetings, the climate change data,

the sea level rise, population and land use data, extreme events, the wildfire. And that's all feeding into the assessment, which is going to produce quite a large number of products this time. There's going to be a statewide assessment. There's going to be at least nine regional assessment reports and two special topic reports, at least two, one on oceans, one on tribal and indigenous communities. Then in addition to that, there's the funded research projects. We'll produce technical reports, so there will be 31, 32 of those technical reports.

And then we have external collaborators who are people who are working on climate change research that is of interest to the state, and they have additional funding sources. And so they are participating in our effort. And so there will be some additional research/technical reports from those external collaborators.

And then all of that suite of research is going to produce new tools, improved understanding of climate change processes, adaptation options, mitigation measures, and provide new datasets, and hopefully provide some new information that will help decision makers.

And right now those research projects are being managed by their funding source, but we are collaborating very, very closely together.

So I am managing the natural resources projects, which cover a wide variety of topics. We have wildfire. We have sea level rise. We have coastal and oceans, carbon, drought, public health. And then there's the energy sector projects, which Susan is doing an excellent job of managing. And then Joey Wall from the Energy Commission is managing all those external collaborators who are kindly giving their time and effort to the Fourth Assessment. We work very closely together. We meet every other week at a minimum to talk about coordinating these projects. We hold joint quarterly meetings where all the researchers get together and get to share their findings and talk about processes for the Fourth Climate Change Assessment.

And one new thing that we have done this year for the natural resources projects is we've linked -- well, actually, for all of the funding projects, each of the research teams has been linked with a technical manager that's from a state agency. So that brings in people from the

Energy Commission, CAL FIRE, the Insurance, Food and Ag, Department of Water Resources, and a lot of other state agencies. And what we're trying to do is to get the researchers from the get-go as they're putting their projects together, talking to people who are at state agencies so that they can make their research more directly applicable to state processes and policy.

And Cal-Adapt has been an integral part of the Fourth Climate Change Assessment. It's the main way that we have disseminated data to the research teams. And they have been especially thrilled with the upgrade to include the netCDF format, which has made the information more useful to the research community. They use Cal-Adapt to visualize and communicate the regional impacts of climate change. And the researchers said they are especially liking the tools that do extremes and averages. There's been a lot of the extreme heat day tool, and of the wildfire information that is available on Cal-Adapt. And that this has been a really good tool to help the researchers to connect to the public.

And one of the researchers, David Ackerly

from UC Berkeley, I liked his quote, so I wanted to go ahead and say it word for word.

"When I'm giving public talks, I often take a screen shot of the heat wave tool, selecting the local grid cell where I'll be giving that talk that shows the local heat wave threshold and future projections. The adjustment to the local thresholds really helps the audiences connect."

So Cal-Adapt, you know, being able to find the information that is relevant to the location where people are has been really a very valuable asset.

Now I'm going to just talk briefly about three of the projects that have some implication to the energy sector. And one of those projects was looking at the additional extreme heat days by midcentury. So the green is increases in heat days from like 0 to 10 days, up to the oranges and reds are 20 to 30 increase -- 30 days increased by midcentury of extreme heat days. And what their analysis is -- and for reference, the grey lines are the natural gas lines. And this study is showing that by midcentury, so not that long from now, that the coastal areas are

showing an increase in six to ten per year of extreme heat days. In the inland areas, it could be three to four weeks increase in the extreme heat days.

So another project that has a different flair and is looking at the lessons from the past is a project that's looking at drought planning and climate adaptation of small, self-sufficient water utilities in California. And that is a funded project, Julia Ekstrom at UC Davis. And she also has additional funding to look at the large water utilities, and is providing that as an external collaboration to the Fourth Assessment.

And in this project, they are interviewing and surveying these small utilities to see, what were the lessons they learned in the past drought, that that drought is an experience we have lived through, had to adapt to, that may be a condition that we will see more frequently or more extreme into the future. And so they're really trying to find out, what were the strategies that people used? What were the barriers to being able to adapt those strategies that they had and to, you know, try to see, what

are the lessons we can learn from that moving forward in developing our adaptation policies, and where do we have to adjust the policies that we have to allow that kind of adaptation?

And similar to Susan, I'll do a plug for a workshop. So on September 20th, just right across the street in the hearing room of the Bonderson Building, they will be holding another workshop to talk about those -- if our existing policies allow that kind of adaptation, or if there are any barriers that need to be addressed. So it is open to the public. You are welcome to attend. And if anybody wants more information, please contact me and I can send you the information on that.

And then the last project I'm going to talk about today is the wildfire risk on California's homeowner's insurance market.

And so in the map here the green areas are areas where there's not a lot of change in wildfire risk looking into the future. And the browns and the reds are the areas where wildfire risk is expected to increase due to climate change. And in this study they are going to look at two case studies. The first is the Los

Angeles area, which already has a high wildfire risk. And in that area the wildfire risk is more sensitive to population change than it is to climate change. And then to contrast that, they're going to look at the Sierra Nevada and a community there and looking at there the wildfire risk is more sensitive to climate change. As our snow levels rise the wildfire risk increases in those forested areas.

And so they are going to be able to compare those areas, both in terms of the risk and then the subsequent impacts of that risk on the insurance market. And so the study is looking at how insurance provides a resiliency to those communities who do have wildfire risk. And they want to be able to advise policy makers on the changes in the wildfire insurance market that might be expected under climate change and urbanization, and the subsequent -- and the associated changes to the wildfire risk.

So in terms of the timeline of the Fourth Assessment, the research projects are wrapping up now. They are scheduled to be done at the end of 2017. The researchers are frantically working on that and drafting their technical reports. Those

reports will be peer reviewed in the spring of 2018. And the Fourth Assessment will be coming out -- originally it was slated for fall of 2018. Given that the Governor will be holding a summit in California in September, we're anticipating the release will be more July or August of 2018.

So thank you very much.

MR. STOMS: Thank you, Jamie.

Our next speaker will be Guido Franco, who is going to talk about the climate-relevant parameters for the energy sector that Susan kind of teed up this talk with touching on one example. And Guido will talk about that and some other potential parameters.

MR. FRANCO: Good morning everybody. So I'm going to be talking about climate-relevant parameters, but only for the energy sector. There are other climate parameters that are relevant to other sectors of the economy, but I will focus, again, on the energy.

So what are climate parameters?

The climate parameters are weather or climate-related metrics or variables that are used for the design, management, operation or planning of the energy system. If this looks

familiar to, I think it's AB 2800, it's pure coincidence. Okay.

Why do we need climate-relevant parameters? We have the climates in areas. We have 12 terabytes of data available to us, so why do we need parameters?

In part, it's because inundation of data is not helpful if we are not able to translate that into information. And one way to do it is via identification of climate parameters. Instead of -- so I'm going to give you some examples of those climate parameters.

One of them has to do with what we were asked from our Demand Forecast Office here at the Energy Commission. So in order to estimate, peak -- in order to estimate the amount of capacity in megawatts that would be needed to satisfy the demand in the hot summer months, forecasters used the 95th percentile, that's the 1-in-20 event or the 1-in-10 event, that's the 90th percentile. So they asked us how those percentiles will change with the changing climate? And they used 16 weather stations. Here I'll give you an example of one, just one example for Stockton where you can see, they

start from the present. The 90th -- I mean 95th percentile will go up substantially. So again, like Susan was saying, there is a need for an electricity system to take these changes into account.

Another climate-relevant parameter is cooling degree days. It's the same thing. The Demand Forecast Office told us that they estimate energy demand for space cooling use and heating -- cooling degree days, and for space heating, they use heating degree days. So the same thing, they asked how are they are going to change? So here is one example for Stockton. Again, there will be a significant increase in cooling degree days, an increase in heating degree days. Again, now these numbers are ready to plugged into the Demand Forecast for California.

Original parameters. When a utility wants to install a transmission line, they select the material for the wires based on the maximum temperature that the transmission lines would experience in its entire length. So here is another important parameter that we grabbed from the climate projections.

Another one related is to the natural gas system. So the natural gas system is assigned to provide natural gas to cold customers, almost at any cost. Basically, they look at the coolest day in a 90-day period. I wish I could tell you that the very cold days are going to go away, but that's not the case. The warming is going to be significant with more increases in high temperatures. But we will still be seeing very cold days in the future.

So the other one has to do with a request from Commissioner Randolph. She asked us when -- how the region-wide heat waves are going to change with the changing climate? So she was talking about when we would have very hot conditions in California, but also in Arizona, Utah, Nevada. So I thought I was in trouble because our climate projections are only for California. Fortunately, the federal government was looking at us (indiscernible) the LOCA, the downscaling technique developed for California was an excellent tool. And they decided to support the implementation of them all on a nationwide basis. So now the LOCA is not only available for California, but available via the

federal government at a national scale.

So having that information, what I did with the study is to go and look at, I mean, how the region-wide heat waves will change the future. As expected, the historical period, they are very rare. But look at the next decades -- I mean the next 10, 20, 30 years, up to 2050. They go up. They become more frequent. But not only that, like Susan was saying, they become more intense.

-So a little bit of background. There was a note in Science -- I'm sorry, in Nature, a highly prestigious scientific journal, saying that we would have three years to save our climate, the note that was cosigned by Governor Brown, basically saying that global emissions can increase for the next three years, and then must come down substantially if we have -- if we want to be able to comply with the Paris Agreement. And the Paris Agreement is to limit warming to no more than two degrees C.

So one potential climate parameter that I suggest could be used for California is assume the best scenario. And the best scenario is the climate agreement -- the Paris Agreement will be

achieved. And some people believe that that's impossible now, but let's assume that's possible.

So what will be the implication of California with a global compliance with the Paris Agreement?

So the graph is the -- the graph, obviously, is the classical graph showing increases of temperatures with years. And we have two representative global emission scenarios. That doesn't help us because what -- I don't have it here, but there is -- we have a limited amount of carbon, additional carbon that could be immediately (indiscernible) for that. And exceeding that amount will negate the achieving the Paris goals.

So what we did is -- what we did is last -- I mean, what we reported in the 2016 IEPR, the idea doesn't come from us. This was done at the global scale. Our innovation is (indiscernible) for California, we found the same very beautiful relationship between temperatures and cumulative, global cumulative emissions.

Since we have -- since the -- doing it that way, we have a very simple relationship between temperatures and cumulative global

emissions, not only at a global scale, but also for California, and even onto the local scale, the grid cell that's not shown here.

So the red area shows compliance with the Paris Agreement. And what we find is that temperatures in California will go up from the present levels from 1.6 to 2.8 degrees Fahrenheit. And that's on top of the warming that California has already experienced since 1895 of about two degrees Fahrenheit. So my suggestion is that at a minimum, California should start preparing for this level of warming.

Concluding remarks. So I think -- I hope I convinced you that climate parameter are -- climate-relevant parameter are useful tools to engaging in conversation, to connect with stakeholders and petitioners. I think Brian will give some examples, I believe. And finally, I mean, some of the suite, some of these climate parameter will be available eventually in Cal-Adapt.

So with that, thank you very much.

MR. STOMS: Thank you, Guido.

So now we'll change course slightly and have -- hear from the IOUs, instead of from state

agencies. So our first speaker is Brian D'Agostino from San Diego Gas and Electric, who will talk about a couple of vulnerability and adaptation studies that are being done as part of the Fourth Assessment.

MR. D'AGOSTINO: Yes. And thank you very much.

Good morning everybody. It's certainly a pleasure to be here and give an update on our latest projects.

One thing I wanted to mention is a big part of our climate resilience, our partnership in the DOE, the Energy Sector Climate Resilience. That's a big component. Also, being a National Weather Service storm-ready organization, and then having NOAA recognize us as part of their weather-ready nation, just something that I think goes a long way in our ability to anticipate and prepare for some of these extreme weather events that we face.

But really what we're here to talk about specifically is a status update on our Fourth Climate Change Assessment project. We're looking closely at both the electric system and the natural gas system, looking at adaptation

options. And this is where we're integrating a lot of these tools. Technically, we have two separate projects, but we are treating them as one. We're looking at all threats to the natural gas system. And this is based on San Diego. But, of course, with Southern California Gas Company, there are very close ties, of course, with our engineering. So this ends up spanning across both companies, even though we're really focused on San Diego.

And when we look at the overall task, step one was a really in-depth literature review, try to understand what has been done out there. And this is a place where our partnership in the DOE has really helped, because the connections there enabled us to start working with East Coast utilities, Gulf utilities, and start understanding best practices, so a very valuable piece.

The next piece is where we really leveraged lots of Cal-Adapt data. And I have more examples of that coming up. But that's where you take the Cal-Adapt data and really look asset by asset at SDG&E's system, and we can start to closely identify exactly what the

vulnerabilities are.

And that brings us to where we've been over the last several months and where we're going to spend the rest of this year, and that is taking everything that we learned from that asset-by-asset study and presenting it to subject matter experts around the company. So we've held workshops and started presenting all of that data.

So overall, exactly what we're trying to get at with these workshops is direct impacts of the coastal hazards, you know, when we're looking at the energy system, and then with the natural gas, you know, all the hazards, you know, how does wildfire impact the natural gas system and things like that, so that our researchers, ICF, can give really targeted adaptation options as our next step.

So on Monday, May 22nd of this year, we had our first workshop. It was -- we held it at SDG&E. And it was in our Emergency Operations Center. And you can see these organizations that were represented. You know, part of our role was to pull in the leadership from the company, so the head of Grid Modernization, Risk Management.

I know I heard we talked about the risk assessment mitigation phase. So that all got tied into these workshops. Emergency Management, Electric Transmission and Distribution Engineering and Construction Services, leadership from our insurance groups, we all came together. And as part of this project, this very detailed information was laid out for this group.

And then we even went in and picked two very focused scenarios. So one would be a coastal flood event in our Mission Valley -- or our Mission Beach facilities. And then from there this scenario was presented to these groups to get all of them really thinking about, okay, what do we have to be thinking about as a utility from all these different organizations within. So that was really how we started the day.

The next day, we did the same thing for the natural gas system, but we actually did it up at the Gas Tower in Los Angeles because we've been working so closely with the gas engineering from the Southern California Gas Company on this particular project. You know, some of the images that you're seeing there, in the upper right you're looking at, again, just for demonstration

purposes only, you're looking at landslide potential on the natural gas system. In the lower right you're looking at all natural gas system with very high resolution fuels modeling which tells us where native vegetation is, so we can really begin to understand wildfire threat to the natural gas system, something that we've done very closely in San Diego, of course, already with the electric system.

So how we set up after that morning, all of this information was presented to all these different organizations. And then we had breakout sessions in the afternoon, and we broke it into two groups; one really looked at the engineering and the operation of the system, and then the other group really looked at the enterprise risk where we got into the ramp discussions and the insurance discussions and took that side of it.

And the questions that were presented to all of these subject matter experts were really, what are your initial reactions from all of this data that was presented to you this morning? What's going to be problematic? What are some of the key issues that we're seeing? And what are

the specific types of infrastructure or services that would be impacted? I mean, we really started getting into the details where, I mean, we're listing out all the substations. And they're saying, well, that substation would be higher impact because of this one, because of voltages. And, I mean, we really started getting into some of the nuts and bolts of kind of the hazard-by-hazard approach to this.

We then, after those breakout sessions, we reconvened altogether and started looking at interdependencies, I mean, took that step back and, you know, looked at some of the indirect impacts that we could be experiencing. And this whole time, ICF International, who's working with us on this project, is, you know, vigorously taking notes and bringing this back so that it can go into the analysis that is being conducted right now.

So now we head into what are some of our next steps? Our next steps, we've just scheduled our next round of workshops, which will be in the middle of October. And that's when ICF starts to come back and we reconvene all of these experts from around the organization and start saying,

okay, these are options. This is what we can do for adaptation options, you know, really, likelihood, consequences. And as we prepare for this, some of the discussions are getting very targeted, where we're starting saying, okay, well, the outside junction boxes, the electronic components are three feet high in the box instead of one foot.

So, I mean, we're really getting into the weeds here to say, you know, two feet of tidal inundation would be okay, but three feet wouldn't. And, I mean, we're really getting into the details now, looking at the coastal system. So we're expecting some very productive workshops as a next step as we head into October.

As we look at lessons learned, going through this process has created an awareness among different groups in the company. So it's really been an opportunity to educate a lot of the engineering groups and insurance groups and risk groups about the difference between mitigation, how we've always viewed it, and now adaptation, which we're focusing on now.

So some examples, and this is another great way that we've been leveraging Cal-Adapt

recently, is even over the summer there's a new compressor station being built up in Blythe from the Southern California Gas Company. And we've done full analysis using Cal-Adapt. And Susan and I, we've had the chance to follow up on it and talk about the experience, which has been good. But, you know, we're really taking it into account there.

As we heard, Guido mentioned those design standards on the transmission lines coming in now. And we're using Cal-Adapt and providing all that information to our transmission design folks so we can actually update the standards so any transmission line being built in the future will now be using this, you know, what we expect over the next 30 years, instead of the last 30, so really starting to be forward thinking there.

And then we also mentioned the development of new routes where transmission lines are to be built. These groups now are bringing them through our office saying we're looking at these different routes, and we're using Cal-Adapt to say these different routes might have slightly different impacts and different climate components that could be taken

into account, even though the design process. So we're certainly excited how this has been moving forward. I'm happy to provide an update.

And that will be that. Thank you.

MR. STOMS: Great Brian. Very exciting.

And now our last speaker, and we're actually well ahead of schedule at this point, our last speaker will be Scott Tomashefsky from the Northern California Power Agency to give kind of a look at how these tools and the climate data that we're heard about in the previous talks, how that might be helpful to the publicly-owned utilities.

MR. TOMASHEFSKY: Thank you, David. And then I won't take a half-an-hour, even though you said we're way ahead of schedule.

So I do want to thank you for asking me to be here. I know this is sort of a continuation of the conversation that started last June when we had our first adaptation workshop. And, you know, Commissioner Douglas has had a lot of involvement in kind of following along with that. And we've had some good conversations.

And to our membership, and I think just

to back up just for purposes of NCPA, we represent 16 municipalities, 15 retail utilities. Our footprint extends from the coastal regions down as far south as Lompoc up to Redding, now Shasta Lake. We have a number of members in the Bay Area, and also up in the Sierras. So we like to at least think that we are a representation of the typical California consumer. So from that standpoint the question of adaptation and how it fits into the public policy discussion becomes a big deal for us.

And I think our eye-opening event was really the Butte and Valley fires in 2015. That sort of got us into the conversation. And that also got us into a dialogue here at the Commission.

So just in terms of recapping that event, we have a situation in a period of three or four days where we had our geothermal plant at risk with the fires up in Lake County. And then, of course, we had the fires up by Murphy's, along Calaveras County and that way. What happened in that particular instance is the wind direction changed. So the fact that the wind changed was really the only thing that saved the watershed.

But if you talk to our generation folks, their conclusion is that it's not a matter of if, it's just when at this point. You've got watersheds to the south and north of us that have burned. We haven't burned in our particular area for probably about 100 years.

So in terms of how that all fits into the equation, wildfires becomes a big issue for us. And the fact that Cal-Adapt actually provides an essential repository for a lot of this information to make some of those arguments now takes the conversation away from trying to rationalize what the data is that you're using to justify some of your points, but actually allows you to go beyond that to say, okay, we recognize that this is the same dataset. Therefore, it's really important to be able to say, okay, what is it showing, and how do you go from that standpoint.

Now having said that, when we start to look at Cal-Adapt and the ways it can be used, there's a micro aspect of how does it help your local utility, and then how does it help some of the more regional issues? And when we talk about local, in many respects, if you look at an

example, if you look at one of our utilities that has a footprint of three square miles, wildfires is not an issue. It's in the middle of a particular region. But yet the things that it is involved in, in terms of generation resources, makes it an important issue for them. So even though from a micro standpoint something might not be as relevant, it becomes much more relevant in the grander scope of how generation is accessed, and then, also, how that fits in the public policy.

From the standpoint of a micro issue, heating and cooling days, as an example, is very helpful in the sense of trying to understand what your average customer bills are going to be when you start to get into the policy discussion on where utility rates are going and those types of impacts, the importance of how distributed resources fits into that, energy efficiency. It changes the dynamics of how you can address the issues. It's not just a matter of, well, my average bill is $100. Now my average bill is going to be impacted by the fact that your number of heating and cooling degree days are going to change. It changes the dynamics. It changes how

you deal with building standards. It changes a lot of the things that this agency looks at in terms of things it's doing to try and reduce energy load, so it's important in that sense.

Sea level rise becomes an important issue for a number of our members in the Bay Area. And they're involved in their respective groups in addressing that particular issue. But the fact that there is data that can be relied on as a point of reference for us to have those conversations is extremely important.

Getting back to the issue of wildfires. When we had our fire in the geothermal plant, what it did, it did not necessarily damage the plant, because we've had so many fires over the years where it really kind of took most of that stuff away. Calpine had a lot more damage than we did, although it did take out our entire transmission system that went out to the main system in Lake County. And that was about a million-dollar repair to fix that. And, of course, insurance covers that. But insurance now changes in terms of what you can get and what you can't get. It changes the cost and the dynamics, very important there.

The other issue from a policy standpoint is we did have a short-term interruption in terms of geothermal generation. For us, it wasn't quite as long as it was for Calpine. But if you start to look at it from the perspective of you take a hydroelectric plant out of service because of a wildfire, and you're trying to have the same conversation on SB 100 in terms of a 60 percent RPS and 100 percent Clean Energy Standard, you start to think about the importance of how that fits into the equation. So you start to get into questions about funding and prioritization of state funds, and how does the federal government fit into some of the objectives of dealing with vegetation management and the like? So it becomes an important issue.

I will also add, and the other eye-opening impact was last year with Lake Oroville, as much as that's a state water project issue, two of our members are within about a half-an-hour of the 30-foot wall of water. So when they evacuate and it's our smallest two members within the NCPA membership, it's a big deal. So you start to look at these things differently. So getting engaged in these conversations, finding

ways to look at it from a micro perspective, and also a macro perspective, becomes extremely important.

I appreciate the reference to Truckee Donner on that. I will say that they had some significant challenges this year just dealing with the snow, one after the other. And then, of course, you're dealing with runoff, as well. So the fact that that's part of a way that you can look at this information is important. And even though there's different models that show different things, it allows you to at least step back and take a different perspective on that. So even at the smallest of the smallest utilities, there are important conclusions and things that you can reach out of Cal-Adapt, which we would definitely endorse whatever work needs to be done to keep working in that regard.

So just to summarize, there's always the issue of how do all public utilities play in a lot of these environments? With respect to adaptation, there are things we are certainly all doing, whether it's just dealing with our own systems, or if it's getting into the greater public policy debate. We have made a point over

the last year-and-a-half, and at least I'll throw my little pitch in here again, never looking for funding for us for this work, it's more looking for funding for more things related to what CAL FIRE does with forest health. And the $49 million that has been allocated into the Greenhouse Gas Reduction Fund is a start, but it's not nearly -- I would argue it's a disproportionate percentage of really what's needed to address the issues. Because if you look at some of the data that they show in terms of greenhouse gas reduction savings, there's a lot of reduction savings that comes out of that.

The state is still looking at trying to finalize its inventory. You've got the forest action plan that's part of that, as well. And once that gets put into the equation, you start to look at the entire climate program. And as much as we're trying to do in the electricity sector and the transportation sector, if we don't deal with some of these adaptation issues, specific on the wildfire side, we will never get to our goals. And that will actually probably blow our goals out of the water.

I would note, also, just to -- it's nice

to see the announcement from CAL FIRE about the Forest Health Grants. I think that's a move in the right direction. But it would be really nice to have much more funding that's applied towards vegetation management and wildfires.

And with that, I'll stop.

CHAIR WEISENMILLER: Yeah. Actually, some follow-up questions for folks. It might be easiest to start with Scott, just given the flow.

So, as you know, one of the reforms we went through when we went from PIER to EPIC was really a focus, on the EPIC, on the IOUs. They were the funders and it sort of focuses. And trying to figure out if we need to do better? You know, presumably, you, all the POUs, have their own funding for R&D adaptation research. Are there things we can do to better coordinate there?

MR. TOMASHEFSKY: Well, I think conversations like this are helpful. To the extent that there's value on your end for us being involved in those dialogues, I think that's very important.

The other question -- there's always that question of funding that --

CHAIR WEISENMILLER: Right.

MR. TOMASHEFSKY: -- that becomes problematic. And in some respects you could look at it in a number of ways. There's the fact that we're not involved in EPIC funding. Okay.

CHAIR WEISENMILLER: Right.

MR. TOMASHEFSKY: That's the reality --

CHAIR WEISENMILLER: Right.

MR. TOMASHEFSKY: -- of things. And so there's always that question of equity, which I would say that if it's a state issue that's important, there's perhaps a way to address some of the IEPR funding so that some of the funding addresses statewide planning efforts.

CHAIR WEISENMILLER: But again, how much are you guys spending in this area now?

MR. TOMASHEFSKY: What are we spending in there?

CHAIR WEISENMILLER: Yeah.

MR. TOMASHEFSKY: Well, within the EPIC program, we're not spending at all.

CHAIR WEISENMILLER: I know, but I mean --

MR. TOMASHEFSKY: So that, that's --

CHAIR WEISENMILLER: -- you have our --

you know, you have no -- you have a surcharge. You have --

MR. TOMASHEFSKY: Right.

CHAIR WEISENMILLER: We're certainly not poking around at what you're doing with it, but I'm hoping some of it's going there, so --

MR. TOMASHEFSKY: Well --

CHAIR WEISENMILLER: -- in this topic, so how much?

MR. TOMASHEFSKY: Well, the -- let's put it this way, in terms of our addressing the issue on forest health and vegetation management, it becomes less of a question of R&D funding, but is trying to deal with the proactive nature of addressing the issue from a public policy standpoint. So our involvement in a lot of that has been more from the public policy, to date, to try to get additional funding for these particular areas. We've made that pitch on a number of occasions over the last couple of years. It has not been focused on the funding the development of the tool itself.

CHAIR WEISENMILLER: Yeah, but again, how much are you guys spending to try to address these problems?

MR. TOMASHEFSKY: Within our memberships?

CHAIR WEISENMILLER: Yeah.

MR. TOMASHEFSKY: Not directly. We're not spending directly on this --

CHAIR WEISENMILLER: Okay. Now how about reaching out --

MR. TOMASHEFSKY: -- (indiscernible).

CHAIR WEISENMILLER: -- to your communities again so that the communities generally can start -- you're all very well connected to your --

MR. TOMASHEFSKY: Right.

CHAIR WEISENMILLER: -- local government. So --

MR. TOMASHEFSKY: Right.

CHAIR WEISENMILLER: -- again, how much of your expertise can go back to them to help them start thinking about these issues?

MR. TOMASHEFSKY: Well, it's part of the -- from a financial standpoint it's different just in terms of the staffing and priorities that we do in terms of bringing those messages across. We'll bring those messages to Sacramento on a number of occasions. We will clear -- we'll put that as one of our priority issues when we have

our public power data that we come out with every January. There's follow-up discussions that occur there. We're also part of a number of legislative debates on a lot of those issues, whether it's more direct, as it has been in previous years, or indirect through involvements with this. The conversations I've had with Commissioner Douglas and Staff has been designed to try and find ways that we can utilize some of the value that's in here, too, as I would argue is trying to add to the conversation, as opposed to not adding value to it.

So our objective is really adding value to the state conversation on dealing with vegetation management. It's not intended to say, well, how much are we budgeting for that particular thing? We do that as part of the general things that we address when it comes to a lot of the legislative and regulatory work that we do.

CHAIR WEISENMILLER: Okay. Well, how about to the extent you're looking at building infrastructure, how do you take into account climate change?

MR. TOMASHEFSKY: I would -- in --

CHAIR WEISENMILLER: Into -- your planning for infrastructure, new infrastructure?

MR. TOMASHEFSKY: Well, when we're dealing with our municipalities, we have our systems that we're addressing as far as dealing with meeting their loads. In terms of dealing with specific projects and transmission projects, we've been involved in certain things. There's different planning areas and different balancing authorities that are not represented within the NCPA membership that do a lot of that work, as well. We are also involved in some of the conversations that go on there, as well.

CHAIR WEISENMILLER: So switching gears, one of things I think we'll probably hear from Melissa Lavinson this afternoon as one of PG&E's concerns is access into the forest to really start dealing with some of the forest health issues.

MR. TOMASHEFSKY: Right.

CHAIR WEISENMILLER: What are you guys doing in that area? Are you finding similar problems or, you know, how, again, how do we move that along?

MR. TOMASHEFSKY: Well, it is a problem.

We've had problems with trying to get some of the residual runoff that's come into our reservoirs and trying to find places to take that material and bring it back. And we have had some resistance from some of the federal agencies in terms of trying to get the sludge out of there, if you will, you know, getting some of the stuff that kind of comes down and gets caught in our reservoirs.

So we're looking at those type of things. We have to work with some of the federal agencies to deal with some of the roads that have been washed away with some of the problems we've had over the years. So we're working with them to try and get access to improving things when we have problems that occur at our particular plants. Last year we had a number of issues with respect to, you know, just all the deluge of rain and snow, just trying to get access to our watershed.

CHAIR WEISENMILLER: And what about -- I mean, to the extent you have areas where, you know, you have transmission facilities in forests which have not been hit for a long time, what are you doing to deal with their forests out there,

to make sure that they're just not a fire, you know, waiting fire bomb?

MR. TOMASHEFSKY: Yeah. We'll have to check with some of our other folks that are involved in that.

CHAIR WEISENMILLER: Okay. Anything else for Scott, before we go onto Brian? Okay. Yeah.

So, Brian, I was pretty impressed. I guess I was trying to understand, how much does SDG&E work out -- reach out to the community there to really get them sensitized to the issues you're identifying for --

MR. D'AGOSTINO: Right now a lot of the community outreach that's happened in the past has been around wildfire. So there is a Community Fire Safety Program which has been developed, and it's really reaching out to all of the 52 fire agencies. And then through that, there are full-time employees that their job is going community to community. And, you know, we just went through an approved outreach bulletins that get sent to all of our customers with targeted ones and what we determine our highest risk fire area, really encouraging people to establish their fire preparedness plan, and then

also sharing a lot of the data that we've developed, so that's really there.

When we start looking at some of these newer hazards, like with the Fourth Assessment project, it's -- right now we're -- I think it's a tier sponsor of the Climate Collaborative in San Diego.

CHAIR WEISENMILLER: Uh-huh.

MR. D'AGOSTINO: And then I'm personally a member of their Sea Level Rise Group. So we meet, and that helps us to interface with all the coastal communities. In most cases they're sending consultants to represent each of the cities.

CHAIR WEISENMILLER: Uh-huh.

MR. D'AGOSTINO: But we're always there. And that kind of helps us understand the coastal hazard and how each city is looking at it, and then really the approach that each city has taken, which helps us, you know, work with them and interface with them.

So those have been the two main ways we've been working with kind of that public engagement.

COMMISSIONER RANDOLPH: Yeah. I was

going to follow up on that.

So once you've had the opportunity to finish your research and kind of do this work on these other topics, you guys have done such a great job of interacting with the community on wildfire, do you anticipate, you know, sort of being able to spread that to these other issues that you're looking at?

MR. D'AGOSTINO: Yeah, certainly hoping to. And the Climate Collaborative, which I know is a statewide organization, just that, I think that's kind of our gateway to do that.

COMMISSIONER RECHTSCHAFFEN: Brian, I was going to ask you to follow up on one of your last slides where you were talking about how you've used Cal-Adapt in the design of the new Blythe Compressor Station. And then you mentioned, and I wasn't quite clear, you mentioned it's in some of the new routing and some of the new design standards. And your slide talks about how it's in some of the system partnering projects. It sounds like you're in a transition.

But my question really is: Are you systematically -- are you now or are you planning to systematically do that so that if there's a

new project, you will look at Cal-Adapt and look at the location where you're developing it and what the conditions are predicted under a range of climate scenarios and plan accordingly?

MR. D'AGOSTINO: Yeah. And there's really two approaches on how we've seen it.

One of the main approaches, you know, we just have launched a major project to harden Cleveland National Forest. I know it was a long time in the making. And one of the main priorities is saying all of the design standards that go into the rebuild of Cleveland National Forest have to be taking into account the latest climate information. So that's where we started looking at transmission design standards, making sure that those ambient temperatures are all what should be going into the design. And then it also looks in -- so that's one kind of initiative that we're looking at.

And then once we've started with transmission and made sure that, you know, they have all the information that they need to update those design standards, then we kind of look at distribution. Because we have an ongoing project which we call FRM, the Fire Risk Mitigation

Project, which is going to be a major rebuild of the back country of San Diego. So the same thing, is that we want to make sure we're taking into account the latest climate information on all the distribution rebuilds for fire hardening, you know, not just going to steel with proper spacing and everything else.

But the most recent conversation we had was even in the last week, saying we really need to understand the flood zones so that we -- instead of putting the distribution poles, you know, six feet or per the, you know, design standards, we go an extra three feet to account for runoff and other things.

So these are some of kind of the problems or the issues that we're working on now, is really understanding some of those.

When we talk about Blythe, it's slightly different. And that's kind of the same approach when rebuilding the South Bay Substation in the past. We looked at one particularly major project and did kind of a side study just for that.

So at the same time we're, you know, looking to update all the standards. When the

major project came up at Blythe, we looked specifically at that to give operating temperatures and other things over the lifespan of the asset.

COMMISSIONER RECHTSCHAFFEN: Okay. Thank you.

CHAIR WEISENMILLER: Yeah.

COMMISSIONER SCOTT: Brian, I had a question for you. I think the work that you presented that SDG&E is doing is really impressive and very exciting to hear about.

I am wondering if -- and I recognize that the solutions and the priorities are going to kind of change region by region, you know, whether you're in the desert versus on the coast, or something like that. But is there a forum where the utilities across both the POUs and the IOUs are able to share some of this information so that you're not recreating the wheel or each doing kind of the same study in the same space, or how are you crossing utilities to share this data and information?

MR. D'AGOSTINO: Yeah. Starting with the Department of Energy Partnership for Energy Sector Climate Resilience, that really

established the connections between the utilities on this specific topic. We've taken it upon ourselves to do occasional meetings and, you know, also have coordinated closely with SMUD through this process as part of the partnership, so we continue to network. I know we're right now planning to all get back together in D.C. in November, so that's how we're looking at it.

A lot of it is sharing methodologies, as opposed to data itself because it's so finite and asset-by-asset driven that, you know, it becomes more how are you approaching this and vice versa? And then as we get more into the interdependencies, I think that's where we're -- we continue to look into the future. It's something we're diving into now, but understanding it's a larger scale, you know, understanding what's going on outside with our neighbors and other things, which we're looking at now.

COMMISSIONER SCOTT: Great. Thanks.

CHAIR WEISENMILLER: Just following up on a similar question I had with Scott, what's been your experience with Forestry, you know, in terms of getting into Cleveland National Forest to deal

with issues?

MR. D'AGOSTINO: My understanding is there's been a very large effort with persistence that's taken a long time establishing a Master Use Agreement. Again, somebody else would be able to speak to it with more direct experience. A lot of this is secondhand. But I know it was a long process getting the agreements in place to go in and initiate the CNF Project. But I know all that's done and through. And, you know, the project, I believe it actually kicks off the end of this year.

CHAIR WEISENMILLER: Great. So if you can submit something? Obviously I'm not trying to get into finger pointing as much as finding some solutions on these issues.

MR. D'AGOSTINO: Yeah. You asked me to --

CHAIR WEISENMILLER: So if you can follow up in writing, that would be good --

MR. D'AGOSTINO: Yeah. Absolutely. I'll do that.

CHAIR WEISENMILLER: -- particularly if you've got a Master Use Agreement, that would probably be good to get in the record.

MR. D'AGOSTINO: Okay.

CHAIR WEISENMILLER: Okay.

MR. D'AGOSTINO: Great.

CHAIR WEISENMILLER: Thanks.

Switching gears a little bit, I think Guido talked about the importance of having standard scenarios for planning. And I wanted -- you know, obviously, it was great today to see not only Cal-Adapt, and hopefully how that can become a real tool for the utilities and everyone in their planning, but also to hear from Scott on the Climate Console. You know, it's a different model, obviously, coming out a different history.

But I wanted to make sure that the scenarios in Scott's Climate Console match the ones that Guido is trying to and we are trying to make sure we use universally on the climate side.

Scott?

MR. FLINT: Mr. Chairman, that's, yeah, that's a consideration that we have too. And our -- we built our product, the things we're working on, to be pretty modular so changes and updates are easy.

I'd be happy to sit with Guido and work on what part of his scenarios seem to make sense

for the bigger landscape picture that we're looking at.

CHAIR WEISENMILLER: Yeah. I guess the basic instruction is I want to make sure that the scenarios Guido is pushing to be used generally are precisely the ones used in your model --

MR. FLINT: Yeah.

CHAIR WEISENMILLER: -- just to be clear.

COMMISSIONER RECHTSCHAFFEN: Can I just ask, Guido, the parameters you identified, are they proposed ones that the CEC is working on? I wasn't quite clear what the status of the parameters are. It sounds like they're somewhat of a working concept. Are they --

MR. FRANCO: Yeah. It's a --

COMMISSIONER RECHTSCHAFFEN: -- being proposed?

MR. FRANCO: -- working concept. So in the 2017 IEPR, will be (indiscernible) that we need more information about the parameters. And ideally in one year from now, let's say, all of that will be in Cal-Adapt. So when, for example, the Demand Forecast Office is going to do their, next year, Demand Forecast, instead of contacting us to get information, they can go directly to

Cal-Adapt and get it there.

For San Diego Gas and Electric, for example, if they're going to -- this is a hypothetical example -- you know, they're going to have another transmission line, I mean, there will be something in Cal-Adapt that will be customized to make the job much easier.

COMMISSIONER RECHTSCHAFFEN: And who's working on -- under who's umbrella are the parameters being developed? Is it part of the IEPR? It is part of what OPR is doing with the Executive Order on Adaptation Resilience, or who's doing it?

CHAIR WEISENMILLER: Yeah. I think, Cliff, I think our theory has been in the last couple of years is that if we adopt scenarios here for this purpose and make sure that we have a good vetting process with you, with the PUC as part of it, then the PUC can take official notice of it as it's setting what it needs the utilities to do in their planning. So the notion is to try to have at least a central base. And again, this is precisely the reason for today, is to probe on what's going on here and how do we make sure the PUC is comfortable. But it seems really

important that we have the same scenarios being used at the PUC on the planning, the infrastructure planning, as coming out of the best science here.

COMMISSIONER RANDOLPH: So I just want to make sure that we're sort of talking about scenarios versus parameters; right? And I think for the scenarios -- well, I'll make my second point first.

So my understanding, and correct me if I'm wrong, is that the parameters would be developed in -- as part of the IEPR, and then we would be able to take notice of that.

Now back to the scenarios, Scott mentioned that the Climate Console has four scenarios. And then Susan was also talking about the four main scenarios that Cal-Adapt has. And so following up on your question, are those the same four scenarios, or does Climate Console need to be updated to reflect what Cal-Adapt landed on?

MR. FLINT: So as far as the datasets, we're now using the same. As we've built from the DRECP's Climate Console to the statewide, we're adopting and using the same datasets.

We also, from a scenario perspective, we've looked at one, which is the 8.5 scenario, which is one of the scenarios, if you're talking about climate scenarios, which is one of the scenarios Cal-Adapt uses. We just -- our models don't -- our model data just isn't showing the other scenario that's in Cal-Adapt right now. But you could get the same data from Cal-Adapt, so we don't want to duplicate. We don't unnecessarily want to duplicate that.

MR. FRANCO: And one comment. This is -- so, I mean, the Energy Commission, we have funding from EPIC and from natural gas. So whatever we do in Cal-Adapt has to be for the energy sector. But there are plenty of parameters for other sectors of the economy. For example, for agricultural, chill hours is important climate parameters. And chill hours are the number of hours that are between a certain temperature range that are good for crops, like almonds and (speaking Spanish). How do you say that?

UNIDENTIFIED FEMALE: Peaches.

MR. FRANCO: Peaches. Yeah.

So for civil engineering, you know, for

the design (indiscernible) system, they need to use the maximum hourly precipitation. And they are not related to the energy sector, and therefore we cannot, that's my understanding, use EPIC of natural gas funding to develop those type of parameters.

CHAIR WEISENMILLER: But hopefully, if the parameters and scenarios you're developing can be used for like telecommunications or water utility infrastructure planning, that that could be useful to the PUC, although we're not, per se, using utility ratepayer money, electric utility ratepayer money for that part of your effort. Okay. Right?

So again, how useful -- you know, you're our lead scientist here. How useful are the scenarios and parameters we have developed for -- how useful are they for the PUC's purposes in designing telecommunications infrastructure or water utility infrastructure?

MR. FRANCO: We haven't looked at this issue, to be honest.

CHAIR WEISENMILLER: Okay.

MR. FRANCO: So if -- I mean, we need to get a, well --

CHAIR WEISENMILLER: Yeah. Okay. So that's --

MR. FRANCO: -- (indiscernible).

CHAIR WEISENMILLER: That's good. That's good to know. And again, we have the funding limits on how far we can go there.

MS. WILHELM: And I would point out through Cal-Adapt's publicly available API, other sectors can access and manipulate the data once those parameters are identified.

CHAIR WEISENMILLER: Right.

So looking at our utility colleagues, so you've heard both about Cal-Adapt, and also the -- Scott's model. So is there a way we can build -- I'm going to, again, simplify and quote Scott's model -- in your sort of planning and permitting activities?

MR. D'AGOSTINO: I think that the biggest thing we're looking at is consistency with what we're looking at.

I think back to an example that a colleague shared from me, who worked in New York after Sandy. And the information that he ended up using to start to come up with their new designs on how they were going to make their

investments ultimately wasn't universally accepted. So they created all their new standards based off this science. And then when it finally came into getting everything approved, it was saying, well, that's not the right science. So then they ended up going back to Columbia and initiating a utility-funded seven-figure climate study to try to get to a point that there was a universal baseline that everybody could agree with.

So, you know, I think that's a big part of the reason that we're so happy to be using Cal-Adapt and kind of working through this group on our science. And that's part of the conversations we've had with Southern California Edison and SMUD and PG&E is let's really unite on the science piece of this. Because what we don't want to do is start updating these design standards now based on Cal-Adapt and get them all updated and start implementing it into the redesign of the system, and then having it be, well, that really isn't what we're going to have as the standard. So it's a big part of the reason that we're really working closely with Cal-Adapt as the standard now.

COMMISSIONER RANDOLPH: I had a quick question for Jamie about your workshop on September 20th with the water utilities. Is that going to be webcast at all?

MS. ANDERSON: I am not sure, but I can find out and let you know.

COMMISSIONER RANDOLPH: All right. Thank you.

MS. ANDERSON: Thanks.

COMMISSIONER RECHTSCHAFFEN: I had a quick question for Guido, since I have the luxury of having your lead scientists here. And this is a little bit in the weeds, but you were talking about the relationship between emissions and temperature and California paralleling that nationally. We've already gone up two degrees Fahrenheit since the late 1800s. I had read data showing that our temperature increase in California is actually greater than what's happening nationally. And there were some weather stations last year showing three-and-a-half or four degrees Fahrenheit rise from the mid-1800s.

So I'm just curious, do we, because of our climate, our Mediterranean climate and other

conditions, are we likely to see even higher temperature rises than we're going to see nationally?

MR. FRANCO: The last national assessment, I was one of the authors of the last national assessment, indicates that the Southwest is highly vulnerable. So, yes, higher. The increase in temperatures would be more pronounced in the Western United States, especially California, Arizona, and those areas.

With respect to temperatures, what I was showing is the annual average temperatures in California. So there are regional differences, and also seasonal differences. Yeah, so --

CHAIR WEISENMILLER: Guido, where would you expect the biggest impacts to be within California, in terms of the areas?

MR. FRANCO: I'm sorry, in terms of what?

CHAIR WEISENMILLER: To the extent you said these are the averages, and, of course, there are parts where it might be more extreme, could you just identify what the most extreme areas would be?

MR. FRANCO: Now I'm trying to visualize the map.

CHAIR WEISENMILLER: Right.

MR. FRANCO: So the map shows the Central Valley would see the highest increase in temperatures. Also, the high elevation of the Sierra Nevada will see wintertime temperature increases substantially. And, of course, the Southwest Desert areas.

CHAIR WEISENMILLER: Yeah.

MR. FRANCO: It's almost always (indiscernible).

CHAIR WEISENMILLER: No.

MR. FRANCO: Sorry.

CHAIR WEISENMILLER: Yeah. But my impression was that part of what you were seeing was that Sacramento would have less evening cooling and greater temperatures during the day, or at least the Central Valley part.

MR. FRANCO: It's almost the Central Valley part, yeah.

CHAIR WEISENMILLER: Yeah. Yeah.

And I think, Cliff, I was going to docket the recent paper we got from Ann that sort of went through some of the potential, that it's not just two but, you know, four, six, whatever.

Commissioners, any other comments for

this group, or questions?

Again, we'd like to thank you for starting out a great day.

So again, I think we're going to take our lunch break.

MS. RAITT: Yeah. So we'll take a break and come back at 12:40.

(Off the record at 11:37 a.m.)

(On the record at 12:42 p.m.)

MS. RAITT: All right, so we'll go ahead and get started. We're back, and this is the second panel. And this one's on climate impacts in disadvantaged communities. And the moderator is Aleecia Gutierrez from the California Energy Commission.

Thanks.

MS. GUTIERREZ: Thank you, Heather.

It's hot here in Sacramento today, isn't it? And how appropriate, on the day that we're discussing our collective actions around climate adaptation, that it's over 100 degrees. And I also received a Flex Alert this morning.

So with that, earlier today we heard about some of the projections for increased heat in both coastal and inland areas of the state.

We heard about how there are going to be more of these days going forward, and how we need to adapt.

This afternoon we'll hear from four panelists on climate impacts on disadvantaged communities, in particular, and the role of the energy sector.

Before presentations begin, it's important to remember that there are several definitions for disadvantaged community. For the Energy Commission the term is associated with CalEnviroScreen, and it's determined by a combination of economic and public health indicators, as well as other factors. However, some communities that are categorized by CalEnviroScreen as disadvantaged may not self-identify as such, or find the terminology fully describes the challenges or strengths of those communities -- of their communities.

So with that, our first panelist is Sonya Ziaja of the California Energy Commission, who will discuss a framework for considerations of climate impacts in disadvantaged communities, and actions the Energy Commission is taking to incorporate these considerations in these R&D

programs.

MS. ZIAJA: Thanks very much, Aleecia and Heather, and good afternoon.

Before I start, I just want a couple -- to clarify a few things about the title. So first I'll be talking about Energy Commission-funded research development and demonstration, although there is other research in this area besides what the Energy Commission is doing. And secondly, while I will focus on disadvantaged communities in this talk, this is also applicable to vulnerable populations and low-income customers, sort of along the lines of what Aleecia has mentioned.

So here's an outline of what I'll go through. But very briefly, there's really two goals for this talk. One is to give a better understanding of who climate adaptation and energy research and equity considerations really can bolster one another. And the second is to highlight some of the work that the Energy Commission has already begun in this area.

There are two policy drivers for the Energy Commission here.

So one is Executive Order B-30-15, which

gives guidance for climate-related planning and investment to state agencies. And the relevant language here is that state agencies' planning and investment shall protect the state's most vulnerable populations. While vulnerable populations itself is an undefined term, OPR, along with California Department of Public Health, has convened a Technical Advisory Group that is providing some guidance on this, hopefully sometime in the near future.

And then secondly, SB 350. There was a workshop on August 1st, an IEPR Workshop on August 1st, that already described some of SB 350, so I won't go into detail on this. But for those of you who are new to SB 350 in this area, just generally, the focus is on bringing benefits from the changing energy system to disadvantaged communities and low-income customers.

So behind that, those two policy drivers, is this problem. And the problem is that the bio-, geophysical, economic, and public health impacts of climate change are not uniform across California's geography, nor population. And then the added layer to that is that the preexisting inequities can actually exacerbate those impacts.

So what you'll see on the right-hand side in the pastel is a figure that was developed by CDPH. And that goes through some of the climate impacts, as well as the consequences to public health from those impacts.

On the left-hand side you'll see just a couple examples of energy sector-related amplifications of those secondary health impacts. So we want to be careful here, though, because while the energy sector can amplify problems, it can also provide a source of solutions. And we'll talk a bit more about that later.

The Energy Commission has had several prior workshops on adaptation, equity and energy, and we've learned a couple lessons from them, so some of these are presented here. Climate adaptation processes need to all disadvantaged communities to withstand the impacts of climate change, while simultaneously addressing existing inequality. Communities need to be involved early in decision making and research. Processes, therefore, need to be structured to support meaningful partnerships in which community members are reimbursed for their time and expertise.

Research is needed on sensitivity of disadvantaged communities to power outages and surges, advanced energy storage, identification of key infrastructure in need of reliable electricity, so, for example, food banks and shelters, and of aging energy infrastructure that may pose health and safety risks, as well as more case studies. And the case studies here is important because, as mentioned previously, the combination of impacts among disadvantaged communities will not be the same across California, and so the sets of solutions will be different, as well.

And then, finally, adaptation metrics and cost benefit analysis for adaptation should include equity components.

So here's just a couple of examples of how these connections work. So for high heat, there's a need for cooling center reliability, reliable energy service for critical community infrastructure, and reduction of blackout duration.

The second point is a little bit trickier, but the basic crux of it is that as we're encouraging energy efficiency to help

climate mitigation, we're wrestling with the tradeoff of better indoor air quality because, traditionally, air filtration requires a significant amount of energy.

So how can energy research better consider adaptation inequity?

So this chart is to help us conceptualize energy, sorry, energy equity in a way that is actually actionable. So on the left-hand side, these are taken from Jenkin's, et al, 2017, from an article on energy policy. And this breaks down equity attendance into distributional equity, recognition and procedural equity. And there are corresponding types of questions associated with these.

So where are the inequities is really important for "distributional," and how should be solve them?

For "recognition" the key questions here are really who is impacted, and who has traditionally been left out? Who needs to be included? Who needs better access?

And "procedural" is really a question of whether or not there is an effective or fair process, and which new processes need to be

developed?

So we're not starting from scratch here. The Energy Commission and energy sector in general has a number of tools.

So 25 percent of EPIC demonstrations are in disadvantaged communities. For "recognition," we have CalEnviroScreen as a starting point. And while that defines territories, there's still further work to be done to investigate on a project-by-project basis, how communities can be included, and who we should be including from them.

And then for "procedural equity," there's a host of different tools that we have. So, for example, for competitively bid solicitations, we can start scoring them so that we are encouraging community participation, or perhaps requiring it. We can require budgets that are inclusive of community participation. And we can encourage partnering agreement between researchers and communities so that their roles are clearly defined and their expectations are set.

So finally, what can research do?

So in addition to actually providing a clear outcome, the research process itself can be

a tool, as well. So research can help convene. It can bring people together and give an opportunity to collaborate and co-produce a research project that is salient to the community. It can help build a capacity, not just in the community, but also among researchers, policy makers and operations folks at utilities to better understand the needs and capacities of one another and future ways forward.

So I'll just highlight a couple examples of research that's already underway at the Commission. So we have projects to develop microgrids for critical facilities and disadvantaged communities. One of these is located at a medical facility in Richmond, California, and is developing a renewable microgrid.

We have several Advanced Energy Community demonstration projects. This was also already talked about at the August 1st workshop, so I won't go into detail here. But basically these are super-local projects that are two-phased steps so that demonstrations follow an initial analysis. And third, we have smart ventilation

technologies to efficiently improve indoor air quality.

And finally, I'd like to highlight a new approach for research that the Environment Group is testing out here. So we have competitive solicitation grant funding opportunity to develop local urban energy scenarios in disadvantaged communities. And these are designed to inform future demonstration funding and local planning. The key component, though, in this is requiring community participation.

And so what we expect the community to do within this group is to really define what the benefits are that they want to see from new energy projects and new investments in their community related to energy, help us define what the -- what their public health metrics are and what they're looking for, and get a better understanding of their idea of siting. And so we'll learn from that is they will actually be co-producing the set of parameters that are necessary to optimize the scenario work.

In addition to that, we have a couple other more procedural aspects. So we have -- we're requiring the inclusive budget that we

talked about. And we're encouraging partnering agreements. And we plan to learn from this and then take those processes elsewhere to expand it into other research areas.

Thank you.

MS. GUTIERREZ: Okay. Next we have Adam Smith from the Southern California Edison. And he will be sharing SCE's approach to reducing climate impacts in disadvantaged communities.

MR. SMITH: Wonderful. Good afternoon. I'm Adam Smith. I'm the Manager of Climate Policy with Southern California Edison. And I'm going to give you a quick update of what Southern California Edison has been up to since the last IEPR round last year, and also some of our work in disadvantaged communities.

So I just did that. But basically, I'm going to cover, yeah, a quick update for climate resilience, discuss, probably in a little bit greater detail, the disadvantaged community outreach that we've been doing, and highlight one of the Advanced Energy Community projects that's occurring in our service territory, which is a beautiful segue from the last presentation.

So update on SCE climate resilience. SCE

submitted a Joint Climate Vulnerability and Resilience Strategy to the Department of Energy. We identified ten resilience strategies through companywide workshops.

On November 2nd, 2016, SCE held a companywide emergency response exercise utilizing some of the scenarios from our climate vulnerability analysis. That's a picture of the full-scale exercise. And like you could imagine, there's lots of big screens and people walking around with brightly-colored vests. SCE is currently conducting a mitigation review process to facilitate the selection of defined long-term adaptation strategies that will be adopted across the organization.

Just a brief reminder, since it's been awhile since we talked, but Southern California Edison really leveraged the state's Cal-Adapt datasets. Updates to Cal-Adapt have improved our analysis. We were actually working with a couple of the folks who are funded via the CEC, folks from the University of Arizona who have come out to Rosemead to talk to us about some of their research. And so we're basically kind of doing a re-haul of the vulnerability analysis that I

presented to you last year.

And just to kind of give you a sense of what we're talking about here, on the left-hand side, you can kind of see, I think folks are used to seeing when they look at Cal-Adapt datasets, it's kind of an overlay of our infrastructure. The big black lines are large transmission lines in our service territory. There's a small, blue square right there that actually is Mesa Substation.

And what I'm kind of giving you a sense of here is that for all the points of our large infrastructure pieces that Southern California Edison owns or operates, we have this kind of facility-level readout, which you see here on the right, which gives us the chance to kind of dive into a little greater detail to understand, you know, how things are going to be changing over time, and also kind of prioritize areas, at least it's kind of like a first-pass prioritization for us. We could look at those areas, you know, I guess the threat factors, things like maximum air temperature here in August. And you could kind of look at the change at some place like Mesa Substation and compare the change from year 2030

to 2085 to other substations we might have. And those areas that see the largest amount of change are the ones that are kind of, you know, piquing our interest at the moment.

One of the other updates is that SCE is joining L.A. County's Regional Collaborative, which is LARC, the Los Angeles Regional Collaborative for Climate Action and Sustainability. A little paragraph there about what LARC does. But I think the core thing here is that LARC coordinates climate resilience efforts, the land use, transportation, infrastructure, energy, water and public health, and a whole lot of other partners. Metro is part of it. The County of L.A. is part of it. We're happy to join that partnership. We think this form of collaboration is critical to the adaptation and planning of an electric utility. As we know, the resilience plans of the communities we serve will inform our plan and vice versa, and we need to work together. We view the Regional Collaborative structure as a really great way to do that with other folks in our service territory who are considering the effects of climate change.

So to get a little bit more specific here real quick about kind of where we're going, 2015 and 2016, you know, we've done kind of initial research and analysis, mitigation development, some research and analysis. A lot of this has been driven by our engagement in the DOE partnership.

Moving forward, we have a lot of work ahead of us. But I think I'd just direct you to kind of the final column and kind of where we're driving. We'd like to kind of build in climate adaptation actions into the 2020 general rate case. That requires quite a bit of effort in the years 2017 and 2019. And one of the recommendations I'm about to make on the next slide will hopefully highlight the fact that, you know, I think the DOE partnership has been really great for us, and we're super interested in continuing to stay very involved. It's great to see Dr. Zamuda here.

But we really support the recommendation that was found in the California Safeguard and California Plan to kind of create a California equivalent of that process and that partnership. We think, honestly, it could -- if I can go back

a slide -- it can offer us a lot of structure here in, you know, this kind of very crowded column, 2017 to 2019, a lot of work to be done, we think it would be great to go arm in arm with our sister utilities and state agencies through the next couple of years to try and target something like we've pointed out here, the 2020 general rate case.

COMMISSIONER RECHTSCHAFFEN: Adam, I'm sorry.

MR. SMITH: Yeah.

COMMISSIONER RECHTSCHAFFEN: If I could just ask you a quick question?

You want a similar partnership, you say, as highlighted in Safeguarding California. What specifically in Safeguarding are you referring to?

MR. SMITH: I think it was the energy sector recommendations, so just kind of like a sector by sector -- maybe if Louise is here. There's probably someone who could give you a better, you know, from OPR, a better --

COMMISSIONER RECHTSCHAFFEN: I asked Louise and she didn't know. Louise, she's coming. We can ask her.

MR. SMITH: Okay.

COMMISSIONER RECHTSCHAFFEN: But she didn't know either, so that's why I'm asking you.

MR. SMITH: Okay. Yeah. In the energy sector there's recommended actions. And I think one of them was to create something similar to the DOE partnership that had been happening out there. But just because in California, you know, we have some different priorities, things like we want to ensure that while we're adapting to climate change, we're also mitigating, you know, the emissions of greenhouse gases, as well. Those are kind of the additional lenses, I think, a California-specific approach could be useful in helping us think through.

But there's lots of things we learned from the DOE side, as well, so I don't want to discount that. Okay.

Now hopping along to disadvantaged community outreach. Just to kind of orient you here, 45 percent of California's disadvantaged communities, according to CalEnviroScreen, are actually located in SCE's service territory. There's kind of an inset on the right of the Greater Los Angeles Region. But if you pull out

to the left, you can see quite a number of large amount of disadvantaged communities out there in the valley and, you know, kind of out in the desert. Forty percent of all of our residential houses are in DACs or have subsidized electric rates. That kind of tees up in our mind the to ensure that, you know, as we're thinking through climate adaptation, or just, frankly, the future of the electric sector, we're trying to make sure that we keep these communities, you know, in the forefront.

To that end, we've partnered with the Greenlining Institute to develop a kind of community-centric dialogue. We've been working with other organizations. Greenlining kind of helps us coordinate this effort. They facilitate the collaborative conversations. But we have other groups in there, Liberty Hill Foundation, Moving Forward Network, Coalition for Clean Air, folks who both represent the communities. And we also get entities that deliver programs in disadvantaged communities, so groups like Valley Clean Air Now, who administers the Enhanced Fleet Modernization Plus-Up Program. That's kind of like California's Cash for Clunkers Program where

we take, you know, people that can trade in their high-emitting vehicle and get a rebate to purchase an electric vehicle.

So the idea with this dialogue is to kind of, obviously, focus on improved access to clean energy solutions in disadvantaged communities, but kind of working both with those folks who represent the communities themselves, the community groups, and also the people who have, you know, experience delivering programs in those regions, folks like Grid Alternatives, Valley CAN.

Our goal with this dialogue is to kind of develop pilots, potentially regulatory and/or legislative initiatives focused on EVs and community/rooftop solar. I really view, if I can hop back here, I view -- you know, I think we view this dialogue is kind of the place where we are really going to start engaging on climate adaptation. We think a lot of the same kind of solution sets that people are talking about here, improved energy access or, you know, clean energy solution access, electric vehicles, community solar, those are kind of the solutions that, from at least the folks that we've been talking to,

the disadvantaged communities folks we've been talking to, those seem like the kind of solutions they'd like to see us investigate more deeply with them. And so I view this as kind of the dialogue where we are going to do that work.

Hopping along to the advanced energy communities, as you heard, there's a couple of these going on. We have one in Avocado Heights/Basset, which is, I'll show you on a map in just a moment, actually right around the corner from our corporate headquarters in Rosemead. The resilience challenge here, as it's kind of been described, as, you know, San Gabriel Valley extreme head days used to be something like 32 days in a year. But over the next 20 years, this could be expected to rise to about 74 days a year.

And so from that, you know, there's obviously pilots that are being developed packaging community solar and energy efficiency in disadvantaged communities under a grant from the CEC. This project is still in kind of the pilot development stage. Some of the partners are along there, you know, UCLA, the County of Los Angeles, some local community groups that do

the outreach.

Participants in this program would be provided energy efficiency upgrades for their homes at no up-front costs. They'd pay back the costs of the upgrades through their energy bill and, I think, by and by, end up seeing reduced electricity bills. The financial benefits there are lower energy costs, improved efficiency of lighting, cooling and heating system. But there's a whole lot of health benefits, as well, you know, a more comfortable home, better indoor air quality, reduction of heat-related impacts, like asthma, heat exhaustion, heat stroke, and cardiovascular conditions.

SCE views this pilot, you know, as kind of a potentially useful model for other regions, especially with the disadvantaged communities outreach that we've been doing. People are calling for solutions like this, you know, kind of package solutions that address, you know, access to clean energy resources. And it just, frankly, happened to also have really awesome kind of resilience co-benefits. So SCE looks forward to its role as a technical adviser. And I think we're going to be seeking to partner even

more than that.

So just in closing, wrapping up here, I know I gave you a quick tour, but, you know, Southern California Edison really thinks that a California-specific partnership, like the one I described just a little bit ago, would be very, very useful to help structure our work over the next few years, ensure that the utilities are aligned and sharing kind of best practices. We do a lot of talking amongst the IOUs on this subject, so I don't want to pretend that, you know, that hasn't been happening. But I think a kind of structured path forward would be really useful for us. And I think it could also help the communities we serve. Because at the same time, we're developing our resilience plan, those cities, local jurisdictions, large infrastructure providers like Metro are working through their own resilience plans.

The second point, DAC outreach is absolutely necessary. And, frankly, I think it should be included as a work stream -- I'm happy to finish up here quickly -- I think it should be included as a work stream in that, the kind of California-specific partnership.

I also would suggest that we should probably just keep piloting and developing solutions, just like the advanced energy community thing. We have a pretty good sense right now of how much it would cost to replace poles, a lot of the climate resilience investments that we could be making today. There are new solutions, kind of these package solutions, things like the advanced energy communities that we're -- people are piloting, people are talking about.

And I think for some of those threat types that we see further out on the future, we should hold back from just doing the classic kind of repair the physical infrastructure, take a little bit more time to study these things and see if instead we should be focusing on some of these packaged solutions going forward.

So with that, thank you. Sorry for going a little over.

MS. GUTIERREZ: Thank you, Adam.

Our next panelist is Nancy Sutley of the Los Angeles Department of Water and power. Nancy will discuss LADWP's efforts to reduce impacts in disadvantaged communities, as well as the equity metrics developed to assess effectiveness of

their efforts.

MS. SUTLEY: Thank you. I'm going to stand over here, so maybe you can see me.

So I wanted to do a couple of things in this presentation, just to identify some of the major climate adaptation issues for disadvantaged communities when it comes to energy in Los Angeles, and some of our programs, and then secondly, to give you an overview of how we're using data that's being collected through our Equity Data Metrics Initiative to help to link our programs adaptation and our disadvantaged communities together.

Let's see if this works. Nope. Sorry.

So as we think about climate adaptation and how we plan, particularly around disadvantaged communities, we are trying to bring together a number of resources, including climate research. We've invested in some climate research, including some research at UCLA to downscale climate models and to look, for example, at heat, extreme heat days in the city of Los Angeles going forward. We are working with USC's Sea Grant on local sea level rise impacts in the Los Angeles Region. And we also

participate in a number of other -- both research and policy activities. We were a founding member of the L.A. Regional Collaborative and have been on the Board since it started.

Also, in Los Angeles, of course, emergency preparedness, emergency response, has always been an important part of what the city and what LADWP do, so working through some of our emergency planning to develop a more resilient grid and different kinds of designs around the grid to ensure that we can continue to operate is there is an emergency or disaster. And some of those things have benefits when it comes to climate adaptation. We have a lot of customer programs focused on low-income communities and low-income communities and low-income customers. And those programs can help us to enhance the climate programs that I'll talk a little bit more about later.

We also engage in a robust long-term planning process through our Integrated Resources Plan. So we're looking at not just long-term renewable energy goals and energy storage and power generation needs, but also what the demands of the future will be, and also look at rate

impacts. We also worked through our Power Reliability Program, which has a fairly comprehensive schedule for infrastructure improvements. And looking at, finally, at data analytics and metrics to help us to monitor programs and help identify where we're being effective and where we're not.

And then one other resource that's just not really listed on this chart is that we are part of a larger city, and so we work closely, let's see, with other city departments on a whole set of initiatives around resilience that are set out in the city's Sustainability Plan. So those help us to plan and prepare for the future. Okay. (Indiscernible.)

So we look at climate change impacts in Los Angeles, and all of these will be familiar, mostly increased -- and I won't spend much time on this -- increased heat days being a primary concern, sea level rise, as well, for some parts of our city in low-lying areas and communities, like Venice, that are particularly vulnerable to flooding and potential damage to power distribution networks. And then all of the sets of risks that are associated with extreme weather

and drought, windstorms, wildfires, heat storms, like we are experiencing this week, and damage associated with winter storms.

So when we look at our customers, and again, this is not -- these are not unique to LADWP, obviously concerns about higher energy bills for cooling, increased potential of outages due to the strain on our infrastructure, increases in air pollution, particularly where there's low hydropower from drought, certainly increased energy demand and the impact on the operations of our power plans, the decreases in thermal efficiency. And then a whole set of other operational impacts, and also sort of public health impacts across the city. And certainly we recognize that disadvantaged communities in Los Angeles, like in many places, are likely to be the ones most affected by these impacts.

So as we look at programs, our programs, and where those potentially help us to address impacts associated with climate change, putting in a suite of energy efficiency programs, some of them that are directly addressed to disadvantaged communities. We started last year on an Air Conditioning Optimization Program. It was really

more aimed at homes with central air conditioning.

We've had for many years a very successful Refrigerator Exchange Program that we're now expanding to include room air conditioners, since in many poor parts of Los Angeles that don't -- where homes don't have central air conditioning, they will have, you know, one or more room air conditioners which could be very old. So we just launched an Air Condition, Room AC, Exchange Program, an efficient product marketplace that allows customers to more easily both find energy efficient appliances, but also to get to our rebates. We have a Home Energy Improvement Program that's for single-family homes that was started by a grant from the Department of Energy for weatherization. And we run a number of programs, together with the Southern California Gas Company, since we have an overlap in our service territory. So we're able to run some programs, in conjunction with SoCalGas, and some that are specifically aimed at low-income customers.

We, as well, have a Low Income Discount

Program and a senior citizen rate. And we also work closely with the health providers in Los Angeles, both on ensuring that they can continue to operate and have them take advantage of our energy efficiency programs and power reliability enhancements, as well as specific discounts for those who are in need of medical support.

Also, throughout the city there's been a concerted citywide effort around urban heat island effect. We've had a Cool Roof Rebate for a number of years, and now it's part of the city's building code. We're also working with the Bureau of Street Services to pilot some Cool Pavement Programs. And there's a working group among city agencies on urban heat island effect.

We've also been the major supporter of the City of L.A.'s Tree Planning Program. It started out, really, as DWP's Tree Planning Program. And we provide major support for the city's Plants Program, which last year planted about 18,000 trees in Los Angeles.

Our Power Reliability Program (indiscernible) is really aimed around a schedule to make sure that we're addressing our failing infrastructure. And then the lesson I'd mention

here is we've just created a new position for a Low Income and Customer Access Director, who came over from the mayor's office.

So we've been working on our equity data metrics now for about a year-and-a-half. The Board asked us to do this, to look at just to try to identify disparities in services in our energy efficiency programs, also looking at things like contracting and a number of other measures around equity. And we are developing the metrics. We've developed a number of them. But we'll develop about 50 different metrics.

So one of the things, I'll just give you some idea of what now we've gone through, our second round of collecting and presenting these equity data metrics, this is an example, our Tree Canopy Program, clearly very directly related to climate adaptation. And it gives you an idea of where trees are being planted and how that correlates to poverty. So we've been able to overlay the CalEnviroScreen onto the equity data metrics. So again, that helps us to figure out sort of where we need to be making additional types of investments.

This is also the Home Energy Improvement

Program, again, trying to understand exactly who's taking advantage of these programs. That will help us to make sure that we're serving our neediest customers.

And then we've also been tracking both safety and SADY (phonetic), so the interruption frequency and the interruption duration and plotting that against poverty. And we've had -- 2017, so far, has been a tough year, primarily because of the winter storms. So we look at a 12-month rolling average on safety and SADY. And again, 2017, so far, has been a rough year because of the winter storms. And it sort of turns out that with disadvantaged communities that, actually, we have some very wealthy communities in Los Angeles that have not the best service because it needs to be upgraded.

And then just looking, again, across the city at our low-income discounts, and I will wrap up here.

And electric vehicle infrastructure, of course, we have started our EV Car Sharing Program in disadvantaged communities, thanks to some (indiscernible) money.

And then the next steps on the data

equity metrics have been presented to our Board. They -- we will reconvene sort of an Advisory Group that helped us develop them. We're working with Loyola Marymount University to do some independent analysis of the data and really to develop the next step of this. This is really where are there gaps in programs and how do we change the programs based on the analysis that we've conducted.

Thank you.

MS. GUTIERREZ: Thank you, Nancy.

Our final panelist is Amee Raval from the Asian Pacific Environmental Network, who will discuss best practices and the needs that remain as we forge the path forward for disadvantaged communities to adapt to climate change.

MS. RAVAL: Hi. Good afternoon. My name is Amee Raval. I'm a Policy and Research Associate with the Asian Pacific Environmental Network. And I'm really going to be focusing on just some community perspectives as a community-based organization, a lot of which echoes what my colleagues have noted ad are working on already.

So just a little background on the Asian Pacific Environmental Network. We are a

grassroots, base-building organization. And we organize low-income Asian and Pacific Islander, immigrant and refugee communities around environmental justice issues to really advance our vision for clean, healthy and thriving communities. And a fundamental part of our work is really amplifying the voices and vision of our community members and building community power to really be the decision makers for policies and programs in our communities.

So this looks like a variety of different things. It is really based, and the foundation of our work, in local organizing, particularly with Laotian refugees in Richmond, as well as Chinese immigrants in Oakland Chinatown. And again, this is really the core of our work and strategy to build power.

We also build political power through coalition building with alliances such as the California Environmental Justice Alliance. And we do civic engagement, as well, to engage API voters.

And finally, my work is around policy advocacies, both legislatively and in the regulatory space. And that's, you know, what my

role is and what brings me here today.

So just to give you some framing about our perspective as an environmental justice organization, I just wanted to highlight three key trends quickly. One, that economic inequality is widening in the U.S. You know, we're seeing that it's been increasing for decades and reached its highest level, in 2013, since the Great Depression.

The second trend is, you know, our current environmental and climate crisis. You know, our fossil fuel-intensive economy has led to our current climate crisis where extreme weather events will increase in our frequency and intensity.

And finally, you know, there's really exciting emerging innovations in clean energy. And we just want to note that we see these trends, you know, inherently interconnected, specifically because low-income communities of color are disproportionately impacted by the health burdens of fossil fuels and climate pollution. And they will also be hit first and worst by climate change. They also bear a disproportionate burden, energy burden. And

these are the same communities that are both vulnerable to climate change, and also are paying a lot of their income to pay for their energy bills.

And so I just note here that in understanding the interconnectedness, we can use the opportunities from clean energy technicians to spur a new kind of economy that is both based on low carbon energy, as well as addresses the widening climate and economic gap.

And so just to highlight some of the needs in our communities as it relates to energy, I wanted to highlight some key facts from the SB 350 Barrier Study, that the majority of low-income Californians are renters, and that half live in multifamily, affordable housing. And the majority, or over half, speak a language other than English. And I note these because these sort of tell you the unique characteristics that require programs and policies that are catered to these unique household needs.

I already mentioned, you know, our communities have an average energy burden that is much higher than moderate and high income -- higher-income households. And we know that

energy insecurity has major health implications, including increasing incidents of asthma, heart disease, as well as other respiratory problems.

They're also more vulnerable to utility disconnections, which is particularly important when it comes to threats from extreme weather events.

And finally there's, you know, communities that I wanted to highlight, particularly for today, including the homeless, those that are dependent on critical medical equipment and who are really dependent on having their electricity served to them continuously, those that have large families with high energy bills, and our environmental justice communities that live in close proximity to potentially risky energy infrastructure.

And this -- we work on a variety of sort of data collection and reporting. And so we partnered with some researchers at USC and UC Berkeley to sort of just highlight and substantiate some of these characteristics. And this graph here just highlights, you know, the higher percent people of color in a neighborhood, the more emitting greenhouse gas facilities we

see. And this trend is also seen for low-income communities. And so, you know, just sort of highlighting that we are those, we are the ones that are disproportionately impacted by climate pollution and that live in close proximity to potential hazards.

And finally, I just wanted to frame, you know, our perspective on climate justice and resilience. We see adaptation as the process of responding to the consequences of climate disruption. But for us, it denotes more physical threats and infrastructures. And I just wanted to share some of the language that we use in the environmental justice community. We talk a lot with our members about climate resilience, which is really, in addition to physical resilience, includes economic resilience and social resilience, as well as public health impacts. So when we think about solutions, we're thinking very holistically as to how we can both reduce physical threats, as well as improve economic and social resilience in the community.

So again, just for some framing, climate change, we recognize as a threat multiplier that exacerbates existing vulnerabilities faced by our

communities. And as it relates to energy, you know, we know there's a distinct vulnerability of our communities to surges and power outages due to the lack of resources to adapt. We also recognize that there are risks posed by proximity to fossil fuel infrastructure, including abandoned structures, like oil wells, power plants and refineries. And finally, we recognize that climate change will also increase the cost of our members' utility bills. And so there will be real economic impacts that we'll have to think about and consider.

So, you know, I just wanted to share, this is a really dense diagram but highlights the "just transition," which is this key sort of process that we think about that involves a variety of different strategies to move away from an extractive economy towards one that is regenerative, resilient and place based, as well as equitable. And so what I'm going to share today are just some of those examples about what our just transition framework looks like.

So the first example I wanted to offer was emergency management. One of our historic campaigns was developing a multilingual warning

system in 2001, particularly in Richmond where the Chevron Refinery is and where we organize Laotian refugees. The Laotian community in Contra Costa County lives in one of the most toxic regions in the nation and faced a variety of different health hazards from the industrial activity.

Now in March 1999 a major chemical explosion occurred at the Chevron Refinery, followed by two more leaks in June and July. And this really, for the community, revealed the inadequate sort of emergency response system, particularly because the area's residents were poorly informed about how to respond. And our members in particularly, not speaking English as their first language, were least equipped to sort of be connected to the emergency warning system. And so we launched a campaign to get a multilingual warning system, and we were able to successfully put it in place.

And, you know, just some of the lessons here for the energy sector include, you know, the importance of developing emergency warning systems and really targeting outreach to the most vulnerable communities, including those that are

linguistically isolated, and then thinking about the threats from the energy infrastructure in light of extreme events, as I mentioned, power plants, pipelines, refineries, as well as other oil and gas facilities.

The next piece is a lot of the advocacy we do is around energy efficiency. We know that's EJ communities live in older buildings and use inefficient appliances, which contribute to higher energy use. And we know that higher-performing buildings are likely to maintain temperatures, and that's a source of reliable and affordable energy for our communities. And really here to target the elderly and those with medical conditions can have real benefits for resilience, allowing residents to shelter longer at home, reducing their energy spending, and contributing to the economic resilience, as well as having climate mitigate benefits.

And finally, you know, we're very strong advocates of microgrids which, you know, in addition to energy and efficiency include solar and storage and other emerging technologies. But really our advocacy here is about bridging the green divide and making these technologies more

affordable and accessible. And we really want to prioritize those critical facilities, as Sonya had mentioned, that, you know, are serving the most vulnerable communities, including food banks, community centers, emergency shelters, healthcare centers and churches, et cetera.

And, you know, we see that not only can these facilities have backup power in potential power outages, but also double as a shelter for displaced residents, which has that component of building social resilience and promoting communities' ability to cope. And there's also some obvious economic benefits, as well.

So some remaining needs, definitely further research on the economic and health impacts of changes in the energy sector from climate change, both potential negative impacts, as well as the health and economic co-benefits that come from energy upgrades and renewable energy technology.

We also want to continue to build the evidence base to connect climate resilience benefits and impacts from, you know, the issues that our members are facing, like high energy burden, energy insecurity and utility

disconnections.

And additionally, you know, again, strengthening metrics to track multiple benefits and how new projects can support affordability, reliability, and other health and safety benefits.

And again, as I mentioned, we have this holistic perspective. So coordinating and leveraging funding for energy upgrades with other health projects and climate resilience efforts I think streamlines all of the benefits that our members can yield.

And, you know, continuing to strengthen community engagement, I think there's a lot of work to do with partnering with community-based organizations and really involving us from the beginning on a variety of different pieces, including implementation, data collection, and in addition to just the outreach that you do with us at our different member organizations. I think often times we're just seen as sort of a space for checking the box on outreach, but not necessarily a sustainable partner in the longevity of a project from the beginning to the end.

So I'll stop there. Thank you.

CHAIR WEISENMILLER: That's great. I wanted to thank people for a great panel.

I guess I wanted to throw in a little bit on the Edison comments of basically -- you know, and see if there's some way of connecting, you know, obviously, LADWP on it in a way, is that it sounds like for Edison's perspective, one of the things to do is to really, obviously, build on what -- the Task Force with the federal government, have more of a state-specific one which can certainly deal with -- you know, tie into some better to the climate research here or the issues coming into California, but then also set up a process at the PUC to really build in addressing adaptation as part of some future rate cases.

And so part of it is trying to figure out from both of you, you know, how do we move forward on the Utility Stakeholder Group?

And then second of all, I don't know if -- terms of LADWP, how that's build into their GRCs and, again, adaptation issues.

So bounce back and forth, obviously.

MR. SMITH: Well, first, yeah, you know,

I think, I guess, the right process going forward is basically to formalize a lot of the interactions I think we've already been having.

CHAIR WEISENMILLER: Uh-huh.

MR. SMITH: I mean, we've been meeting with Guido Franco and, you know, CEC Staff to talk about the climate research needs. You know, I've seen Christopher Douglas at the PUC to talk about, you know, the future of utility adaptation planning and PUC processes.

CHAIR WEISENMILLER: Uh-huh.

MR. SMITH: So, I mean, we've kind of been having a lot of these conversations. I think from my perspective it's simply just about formalizing the kind of conversations that have already been happening because it's, you know, at the same time, you know, it's nice for us to have kind of ad hoc meetings and it's great to work through that, sometimes outside of the firm regulatory deadlines, you know, kind of approach, having a kind of structured way for the electric utilities to interact, not only with themselves but with the state agencies and other parties. So like that's where I'm really thinking of something like a disadvantaged community work

stream where --

CHAIR WEISENMILLER: Uh-huh.

MR. SMITH: -- we're being able to engage with those folks and kind of sharing with them publicly what we're doing together, and also allow an opportunity for that kind of feedback to come into the, you know, kind of the energy sector's adaptation planning process. It feels like we're all doing that outreach on our own, which is really great. And frankly, a lot of this has to be done at the local level and at the regional level. We have to be interacting with the other groups in our service territory. But there's still a lot to learn from each other. And I think there's a lot of useful opportunities for input into the things that the state is doing, as well, including that research agenda, so --

CHAIR WEISENMILLER: All right.

Nancy?

MS. SUTLEY: We haven't -- I don't think we've been as involved in some of the other utility kind of specific --

CHAIR WEISENMILLER: Uh-huh.

MS. SUTLEY: -- resilience and adaptation

planning. But we've been very involved in the city's resilience and adaptation planning. And, I mean, part of that is, I guess, the benefit of being in a somewhat compact geographic area. Certainly, when it comes to some of our out-of-basin resources, you know, we've been working hard to understand what the vulnerabilities are, both on the power side, and particularly on the water side. And so, for example, we've worked with UCLA, also, on some research around impact on the snowpack in the Sierras. It directly effects our water resources. But in terms of in-basin, a lot of the effort has gone around the city's overall resilience and adaptation planning.

So I think that we would, you know, have a lot to learn and potentially a lot to contribute to something that's more utility specific. But for our sort of day to day and longer term look, it's also very helpful for us to be working closely with other city agencies and other regional agencies through organizations like LARC and others.

CHAIR WEISENMILLER: And that would be good.

I think the other thing is, you know, I think historically, LADWP has been in a real leadership role for the Southern California municipal utilities. And it's not unusual for them to pick up your best practices and sort of move along. So if you can help raise the bar on what's occurring generally in a municipal utility community in Southern California, that would help us a lot, frankly.

MS. SUTLEY: Yeah. We've, for example, been trying to share a lot around what we're doing on the equity data metrics because it's an important effort, but it's also pulling from, you know, fairly readily available data that we have, as well as using some of the screens, like CalEnviroScreen.

CHAIR WEISENMILLER: Yeah. For both of you, I mean, obviously one of the things for the IEPR is it's a good opportunity to come up with some specific recommendations going forward. And, you know, what I've seen so far in drafts is very, I was going to say, very centered around Energy Commission Staff processes, and so like to really elevate this more to some general problem solving going forward. So if we can flesh out

some of those pieces with the PUC, that would be good in terms of the Task Force, in terms of, again, more formal ways of building this into the planning processes going forward.

MS. SUTLEY: Well, I think one way, really, is to engage local government.

CHAIR WEISENMILLER: Right.

MS. SUTLEY: Because, you know, the potential, not just the planning but the potential tools for addressing them, some of them lie, you know, with the city's as well. For example, you know, the City of L.A. adopted a Cool Roof Ordinance to -- and the city has an overall strategy to address urban heat island effect. So I think that -- I think not just looking, you know, looking more broadly than just the energy companies themselves.

CHAIR WEISENMILLER: No, that's very important. I mean, obviously, I think, I was going to say on our level, probably OPR is much more en point with the local governments, but really trying to transform California to deal with adaptation issues. You know, they've got to be front and center going forward, so if you could help there.

The other thing really to help focus on, too, is, you know, I thought in terms of Amee's presentation, it was really good to sort of talk about, from a very concrete, you know, what does this mean for the people on the ground. But, you know, one of the things that was sort of missing there was the impact to freeways, you know, that, as you know, there's a lot of pressure in L.A. to develop right up to the freeways. And there's a lot of good science from the South Coast that, you know, people living next to freeways, you know, their kids have higher asthma, you know, than people living elsewhere. So again, somehow we have to figure out, on those corridors, how to make it safer for people, you know, going forward generally.

But then certainly the big message on Houston, I think as the New York Times early today headlined it as sort of the forgotten parts of Houston where people were just sort of ignored are the ones being hardest hit, and probably being ignored right now as the flood waters are rising. So we have to really build, you know, sort of forgotten neighborhoods into -- put the spotlight as we deal with climate change and

adaptation going forward with sort of the crises that can occur.

COMMISSIONER RANDOLPH: I was interested in talking about the equity metrics. I was particularly interested in Nancy's presentation around, you know, using the data to create these metrics. And I was wondering if Edison is working on that as all, and if OMI is -- if APEN (phonetic) has had an opportunity to provide input into equity metrics in any parts of the state, as well?

MR. SMITH: I can go first. I could tell you, honestly, no, we haven't looked into that. I was taking notes as she was writing it, you know? I was like, oh, great, you know, the SADY (indiscernible), you know, map it over to, you know, the poverty levels. I think it's a really great idea.

COMMISSIONER RANDOLPH: A meeting with Nancy and Adam --

MR. SMITH: Yeah.

COMMISSIONER RANDOLPH: -- will be coming soon.

MR. SMITH: That's right. But, yeah, so --

CHAIR WEISENMILLER: Yeah. No. We've been doing --

MR. SMITH: -- no, but I think it's a great idea, yeah.

CHAIR WEISENMILLER: We've been doing some of that following up on the barriers report, too, on indices. So, again, happy to share that. And I'm sure Heather can get that docketed in this one.

MS. RAVAL: Yeah. Yeah. I think hearing -- I've heard a little bit about the equity metrics before. And I think our partners in L.A., as part of the California Environmental Justice Alliance, are involved in taking a look at that. So I think our partners are involved. And I know that the Energy Commission has a report on metrics which involve one in particularly on climate resilience and critical facilities to really measure how critical facilities are equipped with energy technologies, like solar and storage.

And so to be able to quantify some of the progress, I think is really exciting. And we want to continue to be involved in sort of shaping that process.

COMMISSIONER RECHTSCHAFFEN: I would also say, just because we don't always know what our staffs are doing at the PUC, but as the Chair said, this did come up at the Joint Barriers Workshop with the CEC and the PUC. And we did suggest that both of our agencies look at it and see about trying to incorporate that as a metric going forward to evaluate how we're achieving the goals and recommendations in the Barriers Report, which is a joint CEC/PUC report.

I had this, I apologize because this could take more than negative two minutes, but we need to pull carbon dioxide out of the atmosphere. So we need to regain time, too, for our panel.

But Amee sort of talked about the broader definition of social recovery and resilience beyond simply disadvantaged or susceptibility to environmental harms. And so I really have a thought question, maybe, for Sonya and Adam and Nancy, maybe going forward, which is: Are we too narrowly determining -- and maybe this is for more of us in state government, too -- are we too narrowly looking at what a vulnerable community is for purposes of vulnerability to climate

change's impacts? And when we're designing programs, should we be designing them more than simply providing more efficient apartments or microgrids, but also providing assistance to help with the social vulnerability component of what we need to do? Because as Katrina and Harvey indicate, getting aid, you know, recovering is much more than simply having an air conditioner or a material appliance. It's a whole range of social-political-economic tools that often disadvantaged communities don't have.

So, as I said, it's a broad thought question just to keep in mind. And I welcome for any of your comments.

MS. ZIAJA: So from the Energy Commission research perspective, we're very limited by our funding sources. And a lot of that social vulnerability comes from, as you've pointed out, not just the energy sector. So what we've tried to do is when we're doing, for example, these equity and energy adaptation workshops is bring in other non-energy-related partners and trying to figure out how to work with them better.

So we're sort of aware of like the broader issue, but we have limited tools to

address it. So our best bet so far has been trying to develop better partnerships and developing research that, you know, can leverage what other folk are doing.

MR. SMITH: Yeah. I think that's really right. And, you know, Southern California Edison, you know, serves a whole number of cities who are very interested in not just, you know, the resilience of the energy, you know, the electric sector, but also the broader resilience of the communities that they serve. And I know sometimes I'm envious of my colleague for only having one local government to directly respond to or one city government to respond to. I think we serve over 160 cities.

So, you know, I think the way we define success and the way we define resilience, also, it's not a definition that the utilities come up with on their own, but it's something that we have to engage with regional and local partners to figure out how they want to quantify success in some of these areas. And so if -- frankly, maybe that looks different across different cities. You know, maybe there are some cities that we serve who would really like to ensure

that there's a very, very strong safety net, you know, community cooling centers on every corner. And there could be other cities that don't want to prioritize those efforts.

And our role, as a utility, I think we have a lot to offer to ensure that we're meeting their priorities and their metrics of success. But I also think, you know, defining those metrics of success will be a joint discussion, and we're not the only voice there.

MS. SUTLEY: Yeah. I think that that's, you know, one of the, again, you know, one of the advantages of being in a single, you know, department of a city is that we -- the opportunity to collaborate with other city agencies, certainly the regional agencies, is very helpful in this regard. And the city does have a certain overall framework and the Mayor's Sustainable City Plan, which looks at all sort of facets of, you know, environmental, economy and equity. And if you kind of look through that plan, DWP has a role in sort of like more than half of the initiatives that are part of that plan, and not just limited to, you know, sort of the energy, environment and water pieces, but

really across both the economic and equity sort of chapters of the plan. And so I think particularly around climate resiliency and thinking about vulnerability, you know, of particularly disadvantaged communities that are part of Los Angeles, that is really an effort that we undertake sort of every day within the city.

So, for example, you know, now, today, right, cooling centers are open all across Los Angeles, but we also had a program now for many years, working with the city's Department of Aging. And we give them thousands of fans every summer, so that that they can distribute them to elderly residents of Los Angeles who may not have air conditioning or don't want to turn on the air conditioning because they don't want their DWP bill to be too high.

So I do think, particularly around vulnerability and disadvantaged communities, that interaction with the community as a whole, and particularly with the local government entities that have responsibilities, is really important.

MS. RAVAL: And one thing I just want to add, so again I noted, we work in -- one of the

areas we work in is Oakland Chinatown, that has a rich sort of cultural history. And maintaining the social fabric in the community is really important to us, particularly from the risk of displacement and rising rent. And I just wanted to bring that in because that, for us, is really front and center as it relates to climate and social resilience.

And so as we think about energy upgrades in our communities, like energy efficiency, solar panels and storage, we're also now thinking about how do we, alongside that advocacy, also advocate for tenant protection so that our members can meaningfully benefit from those energy upgrades and investments and projects and, you know, doesn't allow them -- doesn't displace them because they've improved their neighborhood.

CHAIR WEISENMILLER: I really wanted to thank the panel for putting an interesting conversation here.

I have two things. One, as Larry reminded me, that we now have a solicitation out on the street from microgrids that has a group set aside for microgrids and DACs. So, again, certainly encouraging people to be creative in

responding to that program opportunity notice.

And also sort of ask (indiscernible) to think about it a little bit. OPR had a really great event on these issues and trying to figure out if there's a way to get some of the thinking from that into this docket, so we can reflect those, that, in our recommendations.

All right. Okay. So thanks. Thanks again.

MS. RAITT: All right. So our next panel is on making research actionable.

So, folks, we're going to go ahead and set up the front tables with places for the panelists. You can go ahead up to the front tables please.

And as we're getting set up, so Guido Franco from the Energy Commission is going to be the moderator.

MR. FRANCO: Okay. Good afternoon again. So this panel is supposed to talk about making research actionable. It was actually one of the topics that I would like to cover. Another one is, I mean, the identification of win-win strategies, how to -- and basically it has to do with how to adapt to climate variability now as a

good way to adapt to a changing climate and a potentially increasing climate variability.

And one example is a project that we started in 2003, a long, long time ago, where we thought that it would be -- that this would be a better way to manage our water reservoirs in California, the low elevation water reservoirs that are managed using very basic rule curves (phonetic) that were developed in the '70s. So the idea is how to use probabilistic hydrologic forecasts in a modern distribution support system to improve the management with the reservoirs.

To make it brief, the end result was very encouraging. And we used this same type of modeling system for future climate scenarios, and we found out that the same way, new modern way to manage the reservoirs, is not only good for now, but it's also good for adaptation to -- for the future.

So another win-win strategy comes -- the idea came from a presentation by a professor from UC Santa Barbara, like five years ago, when he said the forecasting of hydropower -- of stream flows in California, the summer and the spring, could have an error on the order of 30 percent.

I thought, wow, why so high? And in part it's because we really don't know the -- I mean, the estimation of the amount of water and snowpack is not that good.

So we started, later on, a project with UC Berkeley and UC Merced to help improve the measurements of snowpack in California. So Francesco Avanzi is going to give a presentation about some measurements and telemetry they are using to improve the snowpack measurements in working with PG&E.

MR. AVANZI: Thank you. Thank you for inviting me today. The project I'm going to present to you today is a collaboration between UC Berkeley, UC Merced, PG&E and the Department of Water Resources. And as you see from the title, it's all about obtaining better measurements about snowpack in real time in order to support and improve hydropower operations.

The main motivation of our work is that the hydrology of California is changing. In terms of snowpack, we are observing changes in space and time distribution of snow and faster snow melt. And, of course, these changes can affect runoff in terms of seasonality and volume

and can increase the uncertainty for hydropower operations.

So the main objective of our project is to bridge the gap within the uncertainty in hydropower and hydrologic forecasts on the one hand and the growing demands for better forecasts from hydropower managers on the other hand.

We are dealing with a real case study, an operational case study, that's the North Fork of the Feather River in Northern California. This is a key watershed for the State Water Project. The entire area of the watershed is around 3,600 square miles. But are focusing on the north fork and the middle fork of this placing.

The first step of the project is the installation of four wireless sensor networks, so networks that measures snow and weather properties in representative locations for larger scales. And the red points that you see on these maps are the locations where we are installing our networks. The reason why we chose these four locations with PG&E and DWR is because there were already four snow pillows here. And so the second step is to combine our new information with the historical and the typical information

in mountain watersheds, snow pillows and precipitation gage, and to blend this information with (indiscernible) sensing to support PG&E's hydropower planning and operations with real-time data, distributed data.

And the final step will be to improve and support the decisions (phonetic) systems of PG&E. A good example is the PRMS hydrologic model. In doing this, our priorities are to reduce the uncertainty and increase the temporal resolutions of the forecast, and on the other hand, because we measure snow and weather and physiographically represent the locations, we can also improve the special resolution of existing information about snowpack storage and snow melt in real time.

Here you see the complex infrastructure of reservoirs, powerhouses and channels that are currently used on the North Fork of the Feather River. These give you an idea of one of the reasons why we are working on this watershed. Our wireless sensor networks and general information that we are currently providing will be part of this complex infrastructure and will inform about the expected snow melt and stream flow at each of these powerhouses and each of

these reservoirs in real time. You see the north fork. You see the Lake Almanor on the top. But you see how many of the -- how many reservoirs and powerhouses are actually present.

This is an example of one of these wireless sensor networks. This comes from Bass Lake, but the structure of the networks are similar in the other locations. As you see in the red points that you see on these maps are the location where we are actually taking measurements of snow and weather. These locations were chosen based on physiographic attributes like canopy, slope aspect and elevation. All these points communicate with each other using repeaters, so using a wireless network. And all the data are transmitted in real time to a base station in the middle of the network, which is in direct connection with internet, a server in Berkeley where we receive our data in real time.

As I told you, at each of these locations is already located a snow pillow, but in this case it's more or less here. And in this way we can blend and compare our information with other information from other networks. The spatial

extension of each of these networks is between 8 and 12 hectares, so it's pretty dense around the snow pillow. And the temporary solution of our data is 15 minutes. So even though most of the forecasts are averaged at hourly or daily resolution, we can actually downscale the information at 15 minutes.

Here is an example. You can see how a sensor node looks like. Basically, it's a vertical pole and a horizontal cross arm where we measure temperature, humidity, snow depth, solar radiation in one location per site, and soil moisture and temperature at different depths in the ground. You can also see at the top of this pole the network antenna. That's the antenna that is used to communicate to create the network between different sensors and to transmit the data in real time.

Just to give you a couple of examples of last year, as you probably now, last year was one of the wettest on record for California. Three of our sensor networks were already working during last year. And as you see, they were mostly covered by snow. But we had to do some field work to restore connectivity of some of our

networks, but they are still there, they are still working right now. And so this is a fairly representing result for our future years on the Feather River.

Now just to give you a very short impression of what this data can do, basing on our first results and re-analogies from past year, here you see a comparison between snow water content in Kettle Rock, this is one of our three stations. The black line in this plot represent the snow water content measured during last year from the snow pillow. That is usually installed in a flat and open site. On the hand, the red range and the red line represent the entire viability of snow water content estimated for the 12 nodes that we installed around the pillow.

So what you see here is that, on the one hand, the snow pillow data show a bias compared with the average snow water content from our network at the same site. And this is very important for hydropower managers because it, actually, it can help to track the representative patterns of water content based on some of the physiographic variables that rule snow

variability but are not measured and are not taken into account by the snow pillow. On the other hand, this is a very good example about how to combine our information with historical and traditional information.

At all our sites there was already a rain gage that was installed to measure precipitation. We know that rain gages can be biased during heavy snowfalls because of undercatch. But because we measure snow depth at all of our nodes, we can combine the rain gage information with the increases in snow depth at our nodes. And we can estimate and reconstruct total precipitation based on this complete amount of information. And again, this is very important because precipitation is probably one of the most important variables for hydrologic models and hydropower operations.

Because we measure snow depth, we can also estimate and separate rainfall from snowfall. And this, again, very important because they have a very different behavior in term of hydrologic response. And that's another important information that our network, combined with existing sensors, can provide to hydropower

managers.

Finally, because we measure snow depth under canopy and in open sites, we can also use this information to reconstruct snowmelt runoff for different canopy coverage. And again, this is very important because most of the Californian watershed are covered by canopy. But measuring snow depth and estimating snowmelt under canopy is very challenging and complex, because we measure some of the most important variables below canopy. Here you see an example of the reconstructed snowmelt runoff that we can provide to hydropower managers. And again, you see that comparing the snowmelt runoff under the canopy, the black line with the same snowmelt runoff estimated at the pillow node, you see that at the end of season day is different. And this is, again, very important to know how much of the surface of the base is contributing to snowmelt every day.

So the main idea of the project is to develop the core elements of a next-generation hydrographic data network that take into account special variability in snow and weather in real time. This network can support hydropower

decision makers in real time with more information about the snowpack state. And if the project is successful, we'll be successful, if these projects can improve hydropower to utilities and ratepayers by reducing uncertainty.

Thank you.

MR. FRANCO: Thank you.

So it's nice to have snowpack measurements, but it may be impossible to have it in every water basin in California. So it may be good to try to blend remote sensing with in-situ measurements. And the next presentation is about remote sensing using satellite data by Professor Margulis from UCLA.

MR. MARGULIS: Thank you very much. So this presentation has a very similar motivation to the previous one, but, as Guido mentioned, kind of from a different perspective.

So this is a relatively new project. So here's just the basic objectives we have.

The first is actually, before looking forward in how things are going to change, we wanted to look backward to develop a new dataset that provided spatially explicit information about the snowpack in the Sierra Nevada, so that

was the first goal of this project, with several kind of sub objectives. One is to characterize the degree to which existing hydropower plants involve snow-dominated flows versus those that are more rainfall-runoff dominated. Next, to build better models for current forecasting. And then, ultimately, to understand how water energy resources may change in the future. So we're going to develop a new historical dataset to provide a mechanism for looking forward.

In this early phase, we want to demonstrate potential for improved stream flow from improved snow characterization, so just a basic proof of concept that if we can get snow right, is that going to lead to better runoff forecasts. Demonstrate the potential for improved real-time snow characterization. And then, ultimately, build a near-real-time seasonal forecasting system. So again, these objectives line up well with the previous presentation. And ultimately, these are complementary, where most of these objectives that we state here, we're trying to meet using remote data from satellites. Obviously, if we have good in situ data, that should only improve these forecasts.

So here's just a quick schematic, I won't go over the details, but we've built this system over the last couple years to take in many sources of data that are readily available, meteorological data, topographic data, land cover data, and then, ultimately, remote sensing data. So one of many of the model and datasets that were presented earlier today are model based. And there's now a rich 30-plus year dataset over most sensing data that we can leverage to build new spatially-explicit estimates which we can compare those kinds of models of datasets to. So really, this framework that we've been building is designed to get spatially explicit maps of snow anywhere on the globe. Here, we're focusing on the Sierras and how it's evolving daily, in a given year, and also interannually over the remote sensing record.

So here's just an example of the dataset that we've built for the Sierras. So we focus on the snow-dominated basins over the Sierra Nevada, which is about 20 basins, around 50,000 square kilometers. And because of the remote sensing data we're using, which is called Landsat, we have relatively high resolution, tens of meter

pixel resolution from these satellite sensors. And so we try to exploit that full dataset, Landsat 5 through 8, which spans from 1985 through the present to build this data set. And then using much of this snow pillow network that does exist in the Sierra, we verify this. It works out to about 9,000 station years of comparison to validate it.

And so what's shown here is just a kind of example of some of the data that comes out. On the far right, we have an animation of the yearly peak annual snow water equivalent, which is very useful for water resource managers in terms of the overall storage or volume across the landscape. What's shown in the middle is just kind of if you add up all of the snow over the domain, this shows for any given year how it evolves over the course of the season, when it peaks, how much peak water storage there is, and so on. Okay. So the bottom line is here we've tried to develop this very explicit dataset in terms of spatial patterns so that we can leverage in situ data and other models. Okay.

So given that, we then want to focus on hydropower. And so our goal is to kind of do

this kind of analysis over the full Sierra Nevada range. What I'm showing here, because we're just getting started, are just some example results from a particular watershed, the American River Basin. And so what we started to do is go through and start cataloging all of the hydropower plants that exist, and then using this database that we've created to characterize how snow dominated these power plants are, and then ultimately apply forecasting to these points.

So the first step is just kind of outlining, for any one of these power plants, what upstream area contributes to that. And then we can take that upstream area and overlay it with our dataset to try to characterize how much -- which of these power plants are more or less snow dominated.

And so here's just an example of that. If we overlay those two datasets, the contributing area topographic base dataset and the snow dataset, we get these maps of the average annual snow water equivalent covering each of these upstream areas of a particularly power plant. And so these are in snow-water equivalent units in meters. And so dark blue

represents very deep snowpacks, and white represents shallow snowpacks. And so you see, these are basins at -- subbasins at different scales, some of which are mostly covered by snow, others less so.

So from that we can start building up a database. This is just a list of power plants within the American River Watershed. Some of the key physiographic characteristics of them, including the capacity in megawatts. And then the second to last -- the last two columns is where the snow dataset comes in, what the average April 1st (indiscernible) is over that watershed, and then what percentage of the watershed is snow covered on April 1st in a typical year. And so what this allows us to do is start identifying focused power plants to start looking at. One's the basic, that have both significant power capacity, along with significant snow coverage. And so I've just highlighted a few examples from this particularly watershed that we're going to start looking at. We're going to do this for each of the watersheds in the Sierra, including the Feather, so I think there's a lot of potential for collaboration with the previous

project, and start with these snow-dominated watershed where we think it's going to -- we're going to be able to really zoom in and identify the utility of some of these (indiscernible). Okay.

And so then that leads to kind of the questions, the other objectives and questions we have. And again, these are just a very preliminary examination on a few of these points.

So the first is answering the question: Can we get improved stream flow if we improve the snow-water equivalent characterization? And this seems like an obvious, should be, yes, and that's certainly what we're hoping on. But because of the complexity of the models, our parameters and other things, it's not always a given that putting in a better snow input is going to yield better runoff.

So these are just results from one of these watershed where what we did is we take a free-running model, which is shown in red, the green -- sorry, the blue is the observed runoff at this outlet, and then on April 1st, we put in our snow-water equivalent from our dataset to see whether or not there's going to be improvements

in the runoff, and that's shown in blue. So from this very preliminary analysis we get this kind of first order of fact check, seeing that we're getting improvements in runoff predictions by improving the snow. Okay.

Of course, if that's true, then we need to make sure we can actually improve the snow. And so the second question we've started to look at is what's our ability to improve real-time snow-water equivalent estimates? So we've developed this nice historical dataset, but ultimately we want to apply this is in real time.

And so one of the things that comes out of the dataset that we've developed is that precipitation is very biased, typically, as was shown in the previous slide. So using in situ data often leads to significant biases in snow-water equivalent. So what we've done is to start to mine the dataset to see if we can bias-correct the precipitation to generate better snow-water equivalent estimates.

And so what's shown on the far left here is kind of the snow-water equivalent from our dataset, so you can view that as the reference that we're trying to replicate using what's

called a hindcasting. The second panel is using the nominal precipitation input. And so you see there's a significant underestimation of the snow-water equivalent because of the bias in the precipitation. So clearly, using that and putting that into a runoff model is going to lead to significant biases in runoff.

What's shown in the third panel is just a first attempt at trying to bias-correct the precipitation to get better snow-water equivalent estimates. And we see that we get much better match with the historical data. And what's shown in the far right is just a time series of that. So we see that the black is the reference, the red is the biased nominal simulation, and the blue is this kind of value-added dataset.

So last slide, the next steps for us. So again, we're going to use this Sierra Nevada-wide dataset to characterize the snow-dominated hydropower plants, and then use that database to identify and target large plants that are snow dominated to identify utility. We're going to start talking more directly to hydropower agencies to see the specifics of their forecasting system, so that we can make sure

we're trying to replicate that. And then we'll start building real-time seasonal snow estimation and runoff forecasting systems, test those new systems at these identified hydropower plants, and quantify the potential of the new approach via hindcasting over the historical record. And then, lastly, use this dataset to start characterizing how that forecasting system would be expected to change as climate change impacts snow going forward.

Thank you.

MR. FRANCO: Thank you very much.

So the next talk is by Gary Freeman. Gary is, I think, I'm going to give him a title, he's Chief Hydrologist from PG&E. I think it's close enough. So he will give us -- he will give us a scorecard of how our research is helping or has the potential to help PG&E.

MR. FREEMAN: Thank you, Guido.

So I'm -- before I get into climate change challenges and for hydropower operations, I wanted to just kind of establish a foundation a little bit for starting out kind of how we do a forecast. We forecast, usually, close to the 1st of each month, like February 1 or March 1 and

April 1. So say like, for example, on February 1, how much unimpaired flow or how much inflow has come down the hill? How much is there? We want to establish the present hydrological conditions, how much precipitation, how much snowpack, and then a weather forecast, maybe ten days, that sort of thing, eight to ten days, and then some assumption about the future, you know, if we assume average precipitation and snowpack accumulation, that much going forward, and that becomes a forecast. And that becomes -- then we put it into a plan for our reservoir operations.

So from that, then, I want to then basically look at some of the challenges and areas for research focus. And one of the things that is happening with climate change and hydrological change is a declining snowpack. We're seeing that the snowpack has a trending decline over time, okay? So the snowpack is one of several forms of storage. We've got reservoir storage, we've got groundwater storage, and, of course, as I mentioned, snowpack storage. But snowpack, you know, the storage itself, that medium, to have and be able to measure something like snowpack or reservoir storage, it provides

operational flexibility. And, also, when you have a Mediterranean climate where it's dry six to seven months of the year, that snowpack starts to melt at a time, just as the wet part of the year passes.

And so by March 31st, for example, when the snow starts to melt, we've only got about 17 to 18 percent of the precipitation left to come, so that's very fundamental for filling the reservoirs are held fairly low. And then we depend on that snowpack for filling the reservoirs. As the snowpack declines what we're going to find out is that we're becoming increasingly dependent on the remaining weather. And with that weather is a lot of uncertainty, okay? The remaining weather could be dry, it could be wet, so we may end up not filling a reservoir or we may end up spilling the reservoir. So a lot of the storage is a very important thing in that uncertainty that remains.

The other thing that the utilities, basically, throughout California, what we're looking at, it's not uniform throughout the Sierra. We're looking at the north being lower in elevation by about 5,000 feet, compared with

the southern Sierra. So when you talk about climate change, you talk about hydrologic change, where some of the largest changes are occurring and the most sensitive area to change that's occurring currently or in the near future is in the northern part of the state. It's in the Feather River where some of this work that we've just been talking about is going on. It's also in the central, in the Yuba area, that sort of place. It will eventually be throughout the Sierra. But right now, we're seeing those areas as being more sensitive.

Variability and extremes in seasonal weather, California has one of the highest coefficients of variation in terms of seasonal precipitation throughout the United States, so we could only expect that to get larger, pardon me, that variation to be the bigger extremes in terms of dryness or wetness as we go forward.

And then the other thing that I think is a research area to focus on would be cloud seeding. Many of the utilities, the hydroelectric utilities perform or have performed cloud seeding. And it's been an effective ways over the years, at least it has for our utility,

to increase the snow pack.

So, you know, one of the ways, I mentioned, is the snowpack. The snowpack is an important thing since it is storage and it's really needed and used to define filling the reservoirs for that planning phase of filling reservoirs after the wet season, following the wet season. So, you know, we're becoming increasingly -- as the snowpack declines and we need to increasingly focus on better defining the snowpack and measuring it better, we're looking at technology. You know, we're looking at the airborne snow observatories, a picture here of a flight over the Tuolumne River. We use sensing satellite technologies, such as Steven mentioned, wireless sensor networks, as Francisco mentioned here. And then a better understanding of evapotranspiration. Along with warming with climate change, especially in the northern part of the state, we're seeing a lot of increased evapotranspiration. It's occurring everywhere in the Sierra. But we need good solid moisture accounting, that sort of thing. So these networks, that sort of thing, we're going to really depend on technology to better define the

snowpack going forward.

Atmospheric rivers, a big one there, it shows there just an illustrative example for one, February 27th, 2017. And, you know, we get -- California gets about half of its precipitation from these atmospheric rivers. It seems like in the last years, we're seeing a lot more atmospheric rivers, some are intense, some are not so intense. But very much a concern for the hydroelectric operators, hydropower operators in the sense of the infrastructure. Our infrastructures right down in those canyons are on the sides of a hill with penstocks, that sort of thing, where we have debris flows, mudslides. We really need to get a better handle on the weather going forward.

And as I mentioned, you know, along with the declining snowpack, we're becoming increasingly dependent upon the remaining weather. When we make a forecast in February or March, how much precipitation should we expect? And so improved longer-range forecasting, weather forecasting, very important.

Cloud seeding. A lot of cloud seeding has gone on for several years. And it's, you

know, with the declining snowpack, it's one alternative that we have for possibly increasing the snowpack or adding to it during its decline that we're going to be seeing coming forward. So a lot of questions here. You know, it's been effective, pretty much. My opinion is it's quite effective as a snow maker.

But aerial versus ground seeding, what are the alternatives? Should we be going to higher elevation and using seeding from airplanes, rather than ground-based seeders, you know? And what are some of the alternatives as far as seeding, you know, cloud-seeding alternatives, you know, the nuclei that we put into the clouds? Silver iodide is one of the common ones being used now. But maybe with warmer temperatures, maybe propane or, you know, basically ice crystals, that sort of thing? So there's just various things that can be used. That's, I think, a big research area.

So just in summary, and I'm just going to summarize up some of the just basic points of, you know, some of the research opportunities, I think, that would support climate change adaptation for hydropower operations is, again,

the modeling with improved snowpack measurement. The snowpack is a big thing. As it starts to decline, and we can see it declining, basically, you know, we need better weather forecasting, we need better snowpack measurements, whether it be from satellite or wireless sensor networks, that sort of thing. We need that technology. And then, of course, as I mentioned, additional weather forecasting improvement would really be helpful, because we're going to becoming increasingly dependent upon filling those reservoirs going into our dry period in California, especially the mountain reservoirs, we're going to be very dependent on that weather forecasting. And then, of course, additional cloud seeding research.

COMMISSIONER RECHTSCHAFFEN: Can I ask you a specific question about the atmospheric rivers?

First of all, I've heard different things about that research, some that it's very promising and could really help us do a lot better managing our water supply and dealing with climate change, and I've also heard that some of the modeling is very, very expensive. So I'm

wondering if you could comment on both of those, but also maybe you could explain what PG&E is doing in the way of this modeling and how you're partnering with NASA or other, DWR or others, Department of Water Resources or others who are working this area?

MR. FREEMAN: All right. Okay. Thank you. It's one of those -- the newer areas, I think within the last 10 to 12, 15 years or so that atmospheric rivers have really come into focus. And as far as our operations, these are very strong, intense events, usually, when they occur. And this past January and February, for example, in 2017, this past year, they had a lot of potential to be destructive, that sort of thing, so a lot of focus goes into them.

I can say that at PG&E, we're putting a lot of emphasis on the weather forecasting for these atmospheric rivers. We're utilizing what's available, whatever is available, and that's working. Every day that I know I come into the office I'm looking. The first thing I do is I look to see, during the winter period, to see if there's an atmospheric rivers on its way in, if there's been one forecast, if it's out there, and

then we plan accordingly. We may reduce certain flows through our powerhouses or our infrastructure, like our flumes (phonetic) or that sort of thing, to help preserve them if it's going to be an intense one, so we try to manage around those. That's very much a part of our planning.

So, yes, I mean, I think some of the initial research, I know where they're doing flies and that, they're flying the Pacific and doing that sort of thing, can be -- it might be pretty costly, but it's sure being used. It's being utilized in the utilities, at least for PG&E.

CHAIR WEISENMILLER: Guido, do you want to follow up on that question?

MR. FRANCO: Yeah. So five years ago -- I don't have a timer, so, sorry -- so we started a project that we called CAL Water. And the design of the project was to bring together the physical methodologies of various scientists with the chemists, with the people that look more at the atmospheric chemistry, because the tools weren't working, they were not working together.

So to make it short or to make it brief,

there was an airplane that measured the different clouds and eyes and particulate matter. And what was found is that the small particles in the air make a big difference.

So a new promising way to improve the forecasting of precipitation readings is to include the roles of aerosols, the small particles in the air. And some of these, we thought, will be only the ones that come from California. But actually what was reported in Science Magazine is the transport aloft from Asia and Africa is also very important because dust that comes from far away act as very good cloud nuclei.

UC San Diego is making big progress. Marty Ralph , you may know him, I mean, they are making tremendous progress, working now with Kim Prather , a professor, also at UC San Diego, you know, making sure that the chemistry is also included in the forecasts.

CHAIR WEISENMILLER: Guido had some of the scientists from UC San Diego brief the research CAT (phonetic) at one stage on the atmospheric of his research. Again, that may be something you may be interested in with a follow

up.

I think the other question I was going to ask Gary was just at one point, I think as the Livermore stuff was coming together, there was a sense from PG&E that just the hydro system was responding differently than it had historically, you know, the old proverbial high, medium, low. And there was talk of getting a lot more sensors out into the system. Where did that end up? Or, A, is there -- how much is it the historic, this is your high hydro, your low, you know, this your planning basis? How much is that still applicable? You know, what do we need to do in terms of measurements or whatever to talk about how the system is going to be operating over time?

MR. FREEMAN: You know, as far as sensor networks, we're especially -- you know, and I'll speak for PG&E primarily -- although we go all the way from the Kern River up to the Pit River, we have 16 watershed, but looking primarily at the lower elevation northern part, like the Feather River, a lot of the focus right now is on this wireless sensor network, and possibly better defining the snow over these areas that are very

sensitive to climate change. So this sensor, wireless sensor network, really satisfies some of those technology gaps and that's -- you know, we're going to try to build that into our conceptual models.

We have to shift. It's a kind of a traditional shift from statistical modeling which, you know, you've probably heard the term, stationarity (phonetic) is dead, or whatever, but the time series are changing, the hydrology is changing, so we're changing out technology to physical-type models. And as we do that we're developing, and this is part of the research that's going on, developing the tools to bring this stuff, like from the wireless sensors that Francisco and is talking and describing, and also the satellite technology that Steven is talking about, to bring that into our modeling, this new modeling that's being developed. And we're doing that jointly. We're working with the Department of Water Resources on that modeling.

CHAIR WEISENMILLER: I guess the other question is, obviously, a lot of PG&E's hydro system is coming up for relicensing. And is it comes up for relicensing, it's obviously brought

more into the current mitigation environmental perspective as opposed to the original. So how is all that also changing the operation? I mean, you know, it's not your old hydro system. It's got to be something that's operating in, you know, a much more acceptable fashion environmentally.

MR. FREEMAN: Yeah. I mean, along with warming, we see warmer stream temperatures. We're, you know, we're better trying to define what's out there and what's happening. And again, you only can do so much, but, you know, examples like this wireless sensor network that we're working with the University of California on, and then the Department of Water Resources on the conceptual modeling, will help us define the hydrology that is out there now that's occurring so that we can, basically, write these licenses or work with the partners on this licensing to get meaningful licenses.

CHAIR WEISENMILLER: Okay.

MR. FREEMAN: We need data. We need -- and the technology is going to help support that.

CHAIR WEISENMILLER: Okay.

COMMISSIONER RECHTSCHAFFEN: Thank you.

CHAIR WEISENMILLER: There's certainly things we can do to help on the data side. I assume Melissa may want to chime in some on the regulatory construct when she comes up. But anyway, these are big issues.

COMMISSIONER DOUGLAS: So just a quick follow-up question on the atmospheric rivers.

What do we know about how is effecting or can affect the intensity or frequency of atmospheric rivers?

MR. FRANCO: Well, the last report we supported is three or four years old is that atmospheric rivers will increase with a changing climate. And that's why the forecast or the scenarios or the projections suggest that we will have more intense precipitation. So even if the precipitation doesn't change, the distribution will be such that we'll see more intense precipitation, daily precipitation.

COMMISSIONER DOUGLAS: That makes sense. And so what are the factors, when you look at improving forecasting, I guess accuracy in terms of you're trying to forecast intensity, you're trying to forecast how likely it is that an event will occur? You know, what are some of the steps

to really improve accuracy in a meaningful way?

MR. FRANCO: Well, there are like 16 resource centers around the world that are developing the new generation of global climate models. They are trying to improve different aspects of the models, including this. Some of them believe that increasing the resolution will help, I mean the geographical resolution.

So in the next suite of global climate models that are being prepared for the next IPCC Global Climate Change Assessment there will be better resolution models that will help us better understand what may happen with atmospheric rivers and the changing climate.

COMMISSIONER DOUGLAS: So those models may provide us with additional information that can help us do more localized forecasting?

MR. FRANCO: Yes. But we also have what we call downscaling. But the primary information comes from the global climate models. So improving the global climate models should also improve the climate projections for California.

MR. FREEMAN: As that, I might add, that as that information becomes available we -- on freezing levels, intensity and when it's expected

to arrive, they generally start off kind of on the north part of the coast, generally in the Oregon and Washington area, and then work their way down towards the south. We basically try to determine that timing, that sort of thing, and operate our reservoirs to accommodate those atmospheric rivers as they come down.

The technology and what we're getting from the NOAA Center and from the people at Scripps and stuff has just improved immensely in the last year or two. It's just incredible.

MR. FRANCO: Additional information. As I was saying before, the managers of water reservoirs, I mean, they don't want to use forecasting. They only use historical data. Like, for example, if it has been raining really hard but the next five days are -- I mean, the forecast says it will be dry, they may still release water because that's what the rule says.

Yes, so, yeah, there's a lot of room for improvement in the management of water reservoirs, including the forecasting of atmospheric rivers.

COMMISSIONER RANDOLPH: I had a question about -- for Gary about cloud seeding. And my

question was is that -- you mentioned that you would benefit from some more research about possible types of different -- different types of cloud seeding.

But I was wondering, currently is that something that is time based at all? I mean, do you only do it during certain parts of the season? And will that change going forward with changing conditions?

MR. FREEMAN: Well, that's, I guess, will it change with changing conditions? Yes, we do it only during the winter wet period. And we only do it for certain snow making-type storms, certain wind directions, that sort of thing. We have on staff a meteorologist who evaluates storms that are coming, are they cold enough to seed to increase the snowpack, that sort of thing. They have to be a snow producing-type storm. We certainly don't want to be creating rain or we don't want to be adding to an atmospheric river that's already bringing tropical moisture in. So those evaluations are made.

Will it change going forward? That's

what we want to know. We know that the snowline is rising. And, in other words, the storms that are coming in, when I look at the temperatures versus the storms when it's wet, those temperatures are increasing, especially in northern -- central and northern California. And I just think it's a key area that if we want to continue to cloud seed -- I know PG&E has been doing it since the 1950s on both the Mokelumne and the Feather River. We feel it's a very effective snow-making methodology.

We're going to need to probably do some research or kind of focus on that to see if it's going to change going forward. Do we need to change any of our, you know, how we seed, or are we going to lose opportunities possibly going forward? We don't know. We really don't know.

COMMISSIONER RANDOLPH: So if you tend to do it for cold storms, if you have less cold storms then you would have less opportunities?

MR. FREEMAN: That's correct. And we -- that's a concern. We don't know if that's the direction it's going. We know that the storms are coming in warmer. And that may limit cloud seeding opportunities going forward, unless we

change to accommodate that, maybe with propane, or we go aerial seeding. Those are possibilities. But we haven't changed over the many, many years. And possibly, it might be a good area for research and to investigate, you know, where we're going, maybe do some modeling and kind of visit that as to what would be most effective going forward.

CHAIR WEISENMILLER: I want to thank everyone, and thanks for your help today.

MS. RAITT: So we're scheduled to take a short break until 2:50.

CHAIR WEISENMILLER: Sounds good.

(Off the record at 2:37 p.m.)

(On the record at 2:51 p.m.)

MS. DOUGHMAN: If the panelists could please come to the table, we'd like to get started. If the panelists could please come to the table? Thank you. Okay.

Kristin, go ahead?

MS. RALFF-DOUGLAS: Good afternoon. So this next panel is on managing risk. We have five panelists that are going to give presentations. We have two that have come all the way from D.C. Thank you very much, Craig

Zamuda and Melissa Lavinson. Louise came from next door. Thank you. And, of course, Alan from Berkeley, and Geoff all the way from L.A.

MR. DANKER: Los Angeles, yeah.

MS. RALFF-DOUGLAS: So thank you all for being here.

We're going to start with Louise Bedsworth, who's from the Governor's Office of Planning and Research, who's going to give a presentation on climate adaptation guidance for state agencies.

MS. BEDSWORTH: Great. Well, thank you for the opportunity to talk today. I'm just going to provide a quick overview of the work we did on implementation of Executive Order B-30-15. And for folks who don't track the numbers, that executive order was signed in April of 2015 by Governor Brown. And it set our 2030 greenhouse gas emission reduction target, which we have since codified into law. And it also laid out a number of steps around building -- around adaptation and resilience to climate change.

And so the executive order said that state agencies should take climate change into account in all of their planning and investment -

- float in, float in, so -- and to employ full life-cycle cost accounting, and to evaluate climate change in all infrastructure planning and investment decisions. It also reiterated a number of principles that the state has stated around climate adaptation, that we should be taking action to both build preparedness to climate change and also reduce greenhouse gas emissions, to use flexible and adaptive approaches, that we should be taking steps to protect the state's most vulnerable populations, and that we should prioritizing, where possible, natural and green infrastructure solutions. And it also specifically called out the state's Five Year Infrastructure Plan and the need to take climate change into account in that document.

It directed OPR, our office, to form a Technical Advisory Group to assist agencies in implementation that executive order. It also pointed to the state's climate adaptation strategy, Safeguarding California, which is really our guiding document for the state. The state's adaptation strategy was first drafted in 2009, and we're currently in the second update of that strategy.

One of the key pieces in the executive order was to take this and really talk about how are we going to implement it and to develop implementation action plans. And the California Natural Resources Agency has led that work.

So as we look at Safeguarding California, we try to think of it a lot really as more of a concept, not just a document. So what does it really mean to safeguard and protect California in the face of a changing climate? And we see a number of activities that feed into this. And this, you could draw many more contributions to this, but we have been focusing a lot lately on the state activities piece, and that's the executive order work we've been doing, also local and regional activities, and I touch a bit on that at the end, and, of course, the research and tool development that the state has invested in to support all of this work.

So back to the Technical Advisory Group, and that's what I'll focus on for the remainder of my time, it was roughly 50 members. We started with inviting folks, both inside and outside of state agency -- state governments. We had all of the Executive Branch represented, as

well as a number of our boards and commissions. And then we had representatives from environmental organizations, local governments, utilities, and others in the private sector as part of that group. As tends to happen, it was a very large group. We were focusing on a broad suite of areas. A number of people came in and participated and gave input on specific elements of the guidance document. We met from March 2016 through early this year.

We have drafted a document which is final review and formatting and, I hope, will be out very soon. But I will give you a preview of what is in that.

We organized ourselves a large Technical Advisory Group, but also in a number of small workgroups to focus in on some specific questions around climate scenarios, around community development and equity, around infrastructure, and around metrics. And these were roughly organized around some of the principles in the executive order and in Safeguarding California. And then our product was basically this guidebook that we've been working on. And I think there are two important components to this, which I

think speak a bit to what was talked about in the earlier panel, is there's a question here of, okay, what are we planning for? The future is going to look different. What is we're planning for?

But I think equally important and what often doesn't get a lot of attention is how do we plan differently? It's not just about planning for something that is different, but we need to be thinking in a different way about how we approach our planning and investment and how we think in a much more systematic way about some of the social, economic and community elements of resilience, not just infrastructure. And so I think that was spoken to nicely on the last panel. But I know Commissioner Rechtschaffen asked that question. I think it's critically important that we're thinking about these social dimensions of this issue. And that really is, I think, different than what we've done in the past.

So because this seems to be the trend, we ended up coming up with a numbered, stepped process for state agencies. We chose to go with four steps. But this is really how we organized

the document.

And the first was -- and what we really wanted to do was just walk state agencies through, at a high level, a process that we could apply across the full range of missions and goals that we have across a diverse set of state agency actors.

So our first step was really to think about how climate change could affect your project or your plan? And so what are the impacts of concern? What are the things that you plan around that could be affected by climate? We started calling these climate-sensitive planning parameters. What are things you would want to track to understand how climate change is affecting a project or a plan? And then once you've done that, setting up a risk framework, and I'll go into each of these steps in a little more detail, to think about, okay, how does that then inform a choice in an analytical approach, as well as what kind of a change in climate scenario you should be planning for. The third step was how to then make a climate-informed planning of investment decision? And that really get so this, how do we plan differently and how

do we bring in these factors that are highlighted as our principles for Safeguarding California? And then finally, really speaking to tracking, monitoring, and how do we really start implementing an adaptive management approach?

So I'll focus mostly here on steps two and three, because I think that's where a lot of the work of the Technical Advisory Group really came together.

So step two was how do we think about climate risk and use that to inform what we're going to plan for, choice of a climate scenario, and then also, what are the various ways that an agency or a department can go about doing that?

And so we started this, really trying, with a qualitative understanding of really let's try to think about the quantity, sort of the magnitude, and the qualitative components of the risks that we're facing and try -- this began with the Technical Advisory Group. At our very first meeting, people started raising the issue of criticality. What is the impact of a disruption? And that disruption can occur from changing average conditions or a point extreme shock event.

And so we started trying to quantify or sort of lay out, what are the kinds of questions you could ask about that criticality question? So we talked about project lifetime, the scale and scope of the risk, the vulnerability and adaptive capacity of that system or community, the nature of the risk. So what is that going to look like in the future if something is impacted, is that going to limit future flexibility? Is it going to lead to something that is irreversible?

And then the other that we didn't list here is the economic elements of that, so what is the economic impact of a disruption? Also, what is the cost to respond to that?

And we translated this. This is, I would say, probably 75 percent of the work of the Technical Advisory Group is how do we take these concepts and map them into informing selection of climate scenarios and analytical approaches? And we came up with a risk matrix approach. And so I apologize, this is small, but what I really want to show is what we talked about was, okay, what are the considerations that you have? So what are the consequences of an impact or disruption? What is the nature of that disruption? Who or

what is effected? And the economic impacts. And then translating that into selecting climate scenarios to plan for. So at the lower end, you would be on a more optimistic scale, on the higher end, a more precautionary scale.

And so we used this and translated it into climate scenarios, so that when you look at Cal-Adapt and you look at the state's downscaled climate data, you could say, you know, most of my answers fall on the far -- the left-hand more optimistic side, it's okay to maybe apply -- to think about a lower climate change scenario, as opposed to on the higher end where you really need to be thinking about a precautionary approach, thinking about high emission scenarios, and doing a much more robust analysis.

One thing I should say is we made the recommendation that for every consideration pre-2050, that every department use high greenhouse gas emission scenarios. And that was because that's the trajectory we are currently on globally, but also, we just don't see a lot of divergence in impacts until later in the century because of the inertia in the climate system.

So we did this risk matrix approach. And

it will be -- this is all laid out in the document. And then we also talked about not just with climate scenarios, but how you can use that to inform an analytical approach? And the reason we did this was we really wanted to recognize that all departments and agencies are at different starting points and have different resources available to them. So we have departments that are already doing very robust approaches to thinking about climate change, and then we have others who really haven't even started. And so this was really to say you can start with doing simple sensitivity analyses or just looking at certain parameters are effected by climate, up to doing very complex scenario analysis, robust decision-making types of analysis.

I think I'm about out of time.

So quickly on step three, how we talked about the decision making differently was we defined resilient decision-making principles. These are around the principles in the executive order. For each of these, we had a workgroup that developed either a checklist or a step-by-step guidance on how to think about

operationalizing these. So, for instance, where we have prioritized actions that promote equity and foster community resilience, there's an equity checklist that was developed that is included in that document. And then we did that for all of these principles.

Finally, I'll just mention, since the executive order was signed we've had a number of important legislative developments that I think advance this work quite a bit.

One is the passage of and signing of Senate Bill 379, which requires local governments to integrate climate change into the safety element of their general plan.

Senate Bill 246 created the Integrated Climate Adaptation and Resilience Program at OPR. Through that, we have an ongoing Technical Advisory Council. And we're developing a clearinghouse to really support integration of climate action across state, local and regional levels.

And then finally I'll just touch on the last one, Assembly Bill 2800, which established the Climate Smart Infrastructure Working Group which the Natural Resources Agency is running.

It's just getting underway, but will go a long way in sort of helping to inform how we start integrating climate information into really the guts of infrastructure planning. And I mentioned those climate sensitive planning parameters. Really, how do we start working on developing that information for infrastructure investors at the state?

And so with that, I will skip my last slide and pass it on to the next speaker. Thank you.

MS. RALFF-DOUGLAS: Thank you.

So next up we have Melissa Lavinson from PG&E. Her presentation is Developing a Flexible Regional Approach to Climate Resilience.

MS. LAVINSON: So thank you for holding today's session, and thanks for having us here today. It's particularly timely, given what's going on in Houston and the fact that, actually, September is National Preparedness Month. So this is a great, great time to be holding this and talking about these issues of how do we move forward?

I think, you know, at PG&E, we really feel that, in California, we have a huge

opportunity to better understand, plan for and be prepared for the expected impacts of climate change. And we recognize that as a critical infrastructure company that serves 16 million people throughout about 40 percent of the state, that we have a critical role to play and that we have a responsibility.

And so as part of that, I just wanted to start out the presentation by highlighting a few takeaways that we've seen, given the work that we've done thus far on climate resilience. And just to put it in context, you know, we are far from the end of this process. We are at the beginning of the journey. But these are just some of the high-level things that we've seen so far. So I want to focus on some of the recommendations. And then I'll just take a step back and go through how we got there, and then we can kind of wrap back up with that.

But just a couple of things, and I think we heard a lot of it already today through the multiple panels, you know, first and foremost, there's a lot of information out there and a lot of work that's going on, both at the utility level, at the state level, at the local level.

But at the moment there's not really, from our perspective, at least one kind of place that people can go to get information that they know is good information, that they know is going to be accessible, and that they know is going to be at least verified in some way, shape or form by, you know, reputable folks at the State of California.

And so we think that having a climate resilience clearinghouse where there's a one-stop-shop for whether you're a company like PG&E or whether you're a small community, whether you're a local government, that can really aggregate the information that's out there and help better categorize it and make it accessible is something that we think would be really important.

Secondly, we talked a lot about it today, the concept of a regional government structure to help local governments coordinate. I think we just saw in the last presentation that there is going to be more and more activity at the local government level, particularly as a result of legislation.

And we know as a company, we're getting

more requests from local governments about information around our infrastructure, vis-a-vis some of the work that they're doing. But we know that doing it community by community can be challenging. And that really, when you think about climate change and climate change impacts, taking a regional approach as opposed to a community-by-community approach we think is something that would actually help with coordination and deliver better results at the end of the day. And we do have really good examples of how we do that in the State of California, particularly something like the Air Quality Management Districts, around pollution. And so looking at that as a model of how could translate that into taking more regional coordinated approaches to climate impacts and adaptation?

Another one that we've talked about a lot today is there's a lot of work going on already in the field of looking at potential impacts, particularly on critical infrastructure, like gas and electric systems. And so ensuring that the work that we're doing at the utilities, and also the work that the state is going to be doing or

localities are doing, is coordinated, and so that we're ensuring that we are leveraging existing work, as opposed to duplicating work that may have already occurred. We know that there's a lot of activity and a lot of excitement to do it, but we think that a better coordination process would be really helpful so that we can leverage dollars, and also leverage information.

And finally, I was really happy to hear the climate smart infrastructure process that will be starting up. Because we do think having joint agency workshops, like this but even expanded, would be really helpful to both identify where we're trying to go and what are some of the metrics that we could develop in terms of what should we be looking at from an infrastructure perspective, and how do we know that we're actually meeting those results? And so working jointly on that, collaborating on what is the end result we want and working backwards from there of how we get there, we think would be really helpful from our perspective, and also from a statewide perspective.

So just a little bit of taking a stepping back of how we actually got to these

recommendations. And I want to put this slide up here because from PG&E's perspective, again, this is something that we know we have a responsibility to address, that climate change is something that's happening, and that we have a responsibility from a mitigation standpoint, but also an adaptation standpoint.

And this is actually our new Mission Vision of Culture that we just revised and we released. And I wanted to put this up here because I think it's critical that you see, in our vision the concept of meeting the climate challenge while providing affordable energy for all customers, that is sort of at the core of what we're looking at. So as we go forward, the way we're integrating climate resilience then into the investment planning that we have at PG&E and into the looking forward in terms of how do we mitigate risk going forward so that we are able to provide that safe, affordable, reliable energy to customers, that is going to be core to what we're doing.

And so some of the things then that we're active on right now is we are working really closely as a result of that, and again, that's

what's driving us, sort of the mission and our vision for the future, we are working very closely with government at state level, but also communities. And we're seeing again that increasing interest in climate resilience as a result of legal requirements, as a result of a lot of philanthropic investments, state processes, as well as funding that we're seeing, both coming out of CEC, as well as funding that we know that's going to be coming down the pipe.

And as we're seeing all this bubbling up, what we're getting is a lot of disparate requests for information. We're getting a lot of kind of one-offs. And we do think that there needs to be some sort of regional approach to climate resilience that can then maybe coalesce up at a state level. Because, as we know, the impacts of climate change are going to be different. They're going to be different in the Bay Area than they are going to be up in the Sierras, and they're going to be different down in L.A. County. And so we have to figure out regionally what's the best approach to address it, both from an adaptation, but then also from a response and restoration standpoint. But then we also need to

understand what individual communities are doing and how what they're doing is going to impact what their neighbors might be thinking about.

So this is something that we think is really critical and why we ask that we think about maybe kind of regional overlays for actually moving forward on impacts of climate change.

The other thing that we're doing is, again, we're not just working with others, but we're looking internally. A couple of things that we're doing at PG&E, and again this is where some of these recommendations come from, obviously, is part of the work we're doing in context to the ramp filing, looking at impacts of climate change actually on our infrastructure and what some of the implications of that going forward. So we're in the process of doing that now. We'll be filing that in November 2017. And that will be used, obviously, in advance of our next general rate case.

But one of the things that we're doing and that we're piloting internally, and I think it was talked about in some of the earlier sessions, is looking at how do we actually take

what we're learning from the modeling and from the information we're gleaning from that and actually put it into practice in our infrastructure investments? So we're starting to develop internally what we're calling our climate resilience screening tool. And we're going to pilot that with some of our higher-end infrastructure investment projects with those projects that are on the books for the $20 million-plus kind of projects, so that we're making sure that we're asking the right questions, that we're taking that into account so that before we make those investment, we've actually addressed the issue of climate change. So this is something that we're starting to develop. I don't have the answers yet. But it's something that we're moving forward with.

We're also taking the opportunity to take the information we're gleaning from some of the modeling we're doing as part of the ramp work, and taking the next step and utilizing visualization maps, excuse me, so that we can better overlay and understand in a really graphical way what are some of the impacts we're seeing and what the implications are overlaying

our existing assets and how that -- how we're going to have to address that going forward.

And finally, we talked about this last time we were here, but again, wanting to really engage with our communities, because we know our infrastructure is only as resilient as some of the activities of our communities. We initiated and launched our Climate Resilient Grant Program. I'm happy to say we're going to be announcing our winners in the coming weeks. But we focused this year on wildfire, and also really focused wildfire and put a premium on asking to get applications from disadvantaged communities. So we're going to be able to announce that, and we're going to then be able to pilot some of those grants, see what we get from that, and then we're going to make the information publicly available.

So I know I'm running out of time. So back to the recommendations, where I started.

So the activities we've undertaken, the assessments we've already done has, again, led us to these four high-level recommendations. There's a lot to unpack in here, and so I look forward to answering your questions as we go

forward.

So thank you.

MS. RALFF-DOUGLAS: Thank you.

Next up is Craig Zamuda of the Department of Energy. And he's going to talk about the Department of Energy Guidance Document on Cost and Benefit Analysis for Climate Adaptation.

MR. ZAMUDA: Thank you. And thank you for the opportunity to address the group.

As Kristin introduced us, she said some of us have come a long way. Let me just make the observation that all of us, I think, have come a long way in terms of the investment that energy has put into building a more resilient system, whether that's been done here based on the information that's been presented earlier today in California, or the work that we're doing as a partnership for energy sector climate resilience that has been referred to by a number of our partners earlier.

I want to compliment and recognize the compliment to our partners for the great work that they've done that they've talked somewhat about today, but there may be other things that they're doing.

But equally important is to acknowledge the great work that California is doing in terms of leading the nation, I think, and in terms of addressing the many different challenges associated with building a more resilient system.

So I'm going to talk about a couple of the things that we are doing at the Department of Energy currently with -- this isn't advancing -- with our partners, since that has been mentioned. I just want to briefly remind our folks here of the partnership, which consists of a number of utilities across the country, perhaps small in number but big in the footprint in the sense of broad coverage across the nation, but a number of different types of utilities ranging from investor-owned utilities, co-ops, state, munis and federal, and of which we have a number of California participants in this partnership.

We've done a lot of work in this space over the last couple of years. For utilities that joined the partnership, they committed to doing vulnerability assessments, to developing resilience plans. We committed to supporting that with guidance, technical assistance, and identifying key gaps in areas that we ought to be

looking to collectively as we move forward. I'm going to mention two of those today. One is really a focus on cost benefit analysis and trying to develop a more robust foundation for conducting that cost benefit analysis. And the other one is on this resilient utility roadmap, that if we have time, I'd like to just briefly touch upon.

In terms of the cost benefit analysis, I mean, the real challenge is to make a business case for these investments. Okay. And where you stand on that is a function of how well we can characterize the costs, both the cost of doing nothing, business as usual, as well as the cost of making the investments in resilience themselves, which is a little bit more straightforward. You know, you can bring in the engineers, you can kind of do the engineering analysis and lay out what the capital costs are, what the O&M costs are.

The benefits category, I think, is a little bit more challenging. And you've addressed, through a number of conversations here, part of that challenge in being able to identify what is the probability of an event

occurring into the future? And in the absence of having -- in the presence of uncertainty there, it makes it more difficult to be able to demonstrate, what are the benefits, when you don't know when that next impact is going to come along for which your investment may ameliorate those implications of that, so that's a challenge.

The other aspect, in terms of looking at the benefits, is also the broader set of benefits that may move beyond just a resilience improvement, so there may be benefits associated with mitigation, co-benefits, et cetera, and how does one adequately take that into account?

And so what we're trying to do with this step, in terms of developing a cost benefit guide, is to lay out kind of a step-by-step approach that could be used to adequately characterize, what are all the various costs that we should be looking at in terms of resilience? What are all the benefits that are part of that equation? That may not be within your scope as a public utility commission, to include all these costs. But when we talk about costs that address benefits to society, is that something that ought

to be included? When we talk about disadvantaged communities, is that something that can be factored in? What we'd like to do is lay out a methodology where one can look at the various costs, one can look at the various benefits and can look at methodologies that have been employed across the country in order to conduct that economic analysis.

In terms of categories of costs, just for illustration purposes, and I'm not going to walk through this, but one can envision there are direct costs to the utility, whether they're restoration costs, replacement costs, they're O&M costs. There are various costs that may vary from climate threat to climate threat. But we'd like to do a better job of categorizing those.

There are also what we'll call indirect costs, the cost to the ratepayers, the customers that might be impacted. We kind of like to look at that. And here are just some examples provided in this slide that talk about out-of-pocket cost, damage cost, health and safety cost, et cetera.

And then there's what we'll call induced cost, for the sake of this conversation, which

are the costs that aren't directly related to the utility and not directly related to the customer or the ratepayer, but they could be broader costs, costs in terms of impacts on society, economic implications, et cetera. And we'd like to, basically, lay out a characterization of the all the costs and benefits. And this is just kind of an illustration of some of the benefits that we'll be talking about. Some of those are kind of directly immediately apparent, reduced or avoided electricity service interruptions, avoided costs, et cetera.

But there are these other things toward the bottom of the slide that kind of get into some of these other benefits in terms of enhanced energy supply, whether it's reduced energy demand, whether it's co-benefits in terms of, as I alluded to before, improvements in terms of mitigate et cetera.

How do we take into account this broad set of costs and benefits to make sure that we have a robust economic analysis?

And then what are some of the tools out there that can be used to kind of compare the costs and benefits?

Here we just have an illustrative cartoon here showing costs on the left matrix and impact on the right. In this case, it's the time it takes for recovery for 90 percent of the outages. And we can see that there's a certain resilience measure cost that we've outlined here, kind of just a hypothetical to show you that as we improve performance, resilience costs will go up. We can't totally eliminate any outages, but you can kind of approach that. But as you do the costs, marginally, are going up.

The red line is basically the costs of interruptions, probably not a linear line in practicality. But you could envision the costs do increase as the outages do improve. And ideally what we're looking for is that crossover where we're getting a maximum return on investment for those investments. In this case it would be this point of least total cost resilience investments.

So there's various methods out there, and we hope to catalog what those methods are to kind of show you how you can maximize that return on investment.

The other issue I want to address very

quickly is this resilient utility roadmap. We know that there's all types of actions that can be taken, many examples given today in terms of improving resilience. What we're trying to do is step back and say how do we really define the attributes of a resilient utility? How do we define a resilient utility in the absence of a disaster? Okay. So we don't want to have this kind of outcome focus where we don't really know the level of resilience until the event has occurred? And then we may be, well, unpleasantly surprised by the degree of resilience or lack thereof associated with utilities.

So what are the attributes for a resilient utility? And we're going to try to develop a roadmap that outlines that, and do so in a way that it's not just that penultimate, resilient utility, but from a maturity model perspective; how do you move towards greater resilience in terms of the various attributes that we would be trying to characterize? And by attributes, I'm just kind of listing a few here, whether it's on governance, disclosure, stakeholder engagement, risk management, investment supply chains. We haven't necessarily

adopted this specific set of attributes.

But what we hope to do for each one of these attributes is provide some language to kind of characterize, what would be -- what would a resilient utility look like vis-a-vis that particular attributes?

So here we have governance. And by governance, we're really looking at how has management defined what the vision is, what the goals' objectives are, what the strategic plan is in terms of building resilience? What are the ways that that has been communicated into corporate policies and plans and strategies? How has that been embedded in terms of defining roles and responsibilities within the organizations, and captured in terms of performance awards for improved performance in terms of enhancing resilience or not?

So there's a number of attributes, we think, that fall within this category of governance. And we hope to kind of have a process that outlines, not just for governance but for these other attributes, what are some of the characteristics we're looking for? We also hope to supplement that with some case studies

where utilities have actually demonstrated resilience vis-a-vis that respective attribute.

And I'll end on this note of our goal here isn't to really define what is that ultimate resilient utility look like, but really to put that in kind of a maturity model perspective. And so this is what this slide tries to do, is to show you that for any one of these attributes, if you pick management engagement, for example, you can see this gradation of improvements as we go from kind of an initiating level of maturity to that one of more of a leading or transforming level of maturity.

So that's our goal is move forward, is collectively to both develop a more robust characterization of costs and benefits, a more robust characterization of what are we all striving to in terms of resilient utility? And our process for moving forward is really to have this as an iterative opportunity to work collectively with regulators, with our partners and broader set of utilities.

And specifically the comment to you all today would be we'd love to work and continue our collaboration with the California Energy

Commission, with the California Public Utility Commission, and have you actively engaged in this process as we're developing this product over the next several months.

Thanks.

MS. RALFF-DOUGLAS: Thank you.

So next up we have Alan Sanstad from Lawrence Berkeley National Laboratory. And his talk is on Addressing Deep Uncertainty and Climate Change Impacts and Adaptation Analysis for the Energy System.

MR. SANSTAD: Thank you, Kristin. I'd first like to thank Kristin and Guido for the invitation to participate today, and Commissioners for your time and potentially your interest here.

So what I want to talk about is what is currently a fairly esoteric topic in the economics of climate change and long-range energy policy, but becoming less so over time, particularly as the topics that we're talking about now, climate impacts and vulnerability, become of increasing concern.

So first of all, what's deep uncertainty, deep compared to what?

There's additional distinction in economics, going back about a century, between risk, which are incompletely known phenomenon to which probabilities can be assigned, and actually, it's important, not just probabilities but probability distributions, and uncertainty, which refers to the absence of that kind of information. Now this is not hard and fast. Any example and practice for the most part -- and with risk the implication is that there are experimental or empirical data on which to base this probability information.

This is a very challenging distinction in some cases. So, for example, the uncertainty characterizations of the IPCC have been worked out over a very long period of time. It's been a very rigorous and difficult process to get to the IPCC, where they are today. So the terminology is not completely standard, but the underlying idea has grown in importance over time. There's no, ultimately, single definition. But deep uncertainties are those that are particularly difficult and/or complicated instances of a second type, where you really don't have rigorous probability information, but you also have

enormous complication or depth of the thing itself.

So strictly speaking, in this arena, regarding impacts and adaptation analysis, and definitely with respect to the energy system, almost everything, if you're being literal, qualifies as this, not just because of the absence of probability information of this type, but because there are large numbers of possibilities, which is to say complexities. So projections, examples such as projections of climate change and, particularly, fine-scale variables, meteorological variables at regional scales, even sub-regional scales, projections of physical and ecosystem impacts of climate change, such as sea level and wildfire, again, at the fine, granular scale, and most certainly the long run evolution of the energy system and its drivers. Even prior to considering climate change impacts, what is technology evolution going to look like? How are economic market and institutional changes going to be manifest over decades? How are economic growth and demographic trends, what are they going to be and how will they affect the energy system?

So although the scenario analysis is sort of the lingua franca of a lot of this, of course, and it's usually not framed this way, but it can be considered as a way of trying to deal with deep uncertainty. So when given scenario choices for any sort of study, choose a scenario or scenarios, and you can apply traditional methods a lot, so you can apply very different kinds of analysis and models and you can do cost benefit analyses, and so forth.

The issue at hand is that with very few exceptions, scenario analysis generally takes account of a very limited degree of deep uncertainty in these kinds of applications, especially over the long run, which is to say a relatively small number of possibilities are usually addressed, so if you think of high, medium and low economic growth, right, or different kinds of climate projections, certainly high, medium and low technological evolution. We've all seen these examples where you take a few examples and you run those, and possibly in great detail. But within each of those, that's a very small sample of a very large space that might have been considered conceptually and

quantitatively.

When you really take this all onboard, a couple of things that are challenges. One is the traditional cost benefit analysis is difficult to apply. Standard decision making on uncertainty methods and stochastic analysis methods are also difficult to apply, what I mean, standard, because they're based on probability information. And, also, our computations are very challenging for large problems, problems that are represented in terms of large models.

In general, finding the concept of optimal solution to a problem in terms of the global optimum, taking all information into account, that is very hard to do. So robustness is a term that comes up a lot in this field. And it refers -- there are -- it means different things to different people; right? It's colloquial, but it's also -- it has technical meanings, but there's more than one of those. It generally refers to identifying solutions to problems that, if not optimal, will be satisfactory in some way under a wide range of circumstances or conditions defined by deep uncertainty.

So it's been exemplified here, I think, today with different possibilities of what climate change will do in California. What is -- how should we consider adaptation policies in the energy system that will work out well under a wide range of these conditions or under a wide range of penetration of renewable technology scenarios and so forth. Anything you might look at there is potentially an example of something for which robust solutions are desirable.

So the trick here is identifying exactly what you mean by satisfactory. Okay, robust, it's going to work out. It should work generally well, no matter what. Well, what's work out well mean; right? How well? You know, what are you -- how are you characterizing that?

So there are technical methods for answering that question. A good -- a well-known example is something called max-min, which given what information you have, you make the best possible decision, assuming that the worst possible outcome, external factor, is going to emerge. So make the best possible -- you know, make your climate-based decisions for energy assuming the worst-case scenario of climate

change, or the worst case scenario as far as the expense of advanced low-carbon technology in the future. So this is a method that's been applied, especially in the climate and economics by macroeconomists. Some of my work and collaboratives in the last few years has been about this, and also energy policy.

An alternative approach, which some of you are familiar with, is just defining the complete space of all possibilities in whatever your space is defining deep uncertainties. So do you have a range of -- you know, for any or all your variables? Do you have, numerically, a range of them? Look at all of -- everything that's defined across all those ranges of inputs.

This method has been pioneered, especially by RAND in Santa Monica, Rob Lempert, especially, in this room. And they've applied this to a wide range of problems. Also, there's a reference at the end of the slide deck about this.

Now in practice, what this comes up against is the fact that -- what this makes challenging, especially, computational modeling is now sort of the, obviously, the dominant

analytic methodology in a lot of areas, many fields, physical, social and engineering science, including, in the present context, general circulation or climate modeling, and certainly modeling in energy economic policy and planning. So this is an emerging field, but so far it is and definitely going to be primarily based on the application of models like this and other solution models.

So in practice, deep uncertainty tends to embodied in the models themselves, not on the structure of the models, their governing parameters, also what input assumptions are built into them, what theoretical assumptions they make about the mathematics of the underlying phenomena.

So, for example, climate models, the general --the numerical models are a very good example. I think Guido mentioned, there are something like 16 research groups around the world running models of this type. They all are and feel equally credible, and they all give different answer, which is to say if you sort of normalize the inputs about things like human emissions of carbon you run the climate for,

they'll all give you some different path. That is a sort of characterization of how deeply uncertain the climate system is with respect to our curtailment knowledge and our ability to model it.

In energy modeling, too, there are fundamental principles, or not as -- you know, they're different from the physics, but economics, economic phenomenon can be described in a lot of different ways. There's sort of basic decision making and economic marketing equilibrium, and so forth. There are many, many ways to build those things into a medium-duty, no matter what you're doing. And things like functional forms, the real, the nitty gritty, when you get down to it, there are many ways to do it that are equally plausible. So this gives rise to a lot of deep uncertain in practice.

So the problem is here, the models are -- you know, they're -- the models that we're talking about are very complex and they're complex for a reason, which is that the phenomena are complex, too, and they're getting more complex over time as more things, clearly, need to be represented.

But the issue here is that the larger the model, the harder it is to address directly these problems of deep uncertainties, including any form of formal robustness analysis. Basically, there are examples where this has been done, for example, energy technology futures with a full-scale model. The one or two examples I know about use super computers. And even then, it's a challenge to set up and run the thing. So the practical examples that I was mentioning before, macroeconomics and the RAND work are generally done with small or low dimensional models.

So as a conclusion, I want to say that continued development of improved methods for these simpler models, in parallel to more complicated analysis, particularly in energy models, could prove very useful. Now this is not wanting simpler models, per se. It's not about deep uncertainty; right? But you might ask, well, useful for who to do what?

So there are examples in California of simpler models becoming very useful. The E3 calculators are a good example. I mean, they're quite simple, compared to what they're based on.

In the last couple of years, I want to

mention, the Aspen Energy Group, under the leadership of Catie Elder and under the auspices of Melissa Jones and Sylvia Bender, has developed a low resolution gas-balance model that complements the very complicated pipeline models.

So these are -- these can come in very handy in particularly cases. But the articulating -- you know, and as the models get more complicated, if one really wants to fully address these kinds of deep uncertainties, they could prove an important avenue to that.

So the issue is how to do this in a way that's articulated with the ongoing, more complicated models? They're not -- those are not, nor should they be, put aside by any means.

So in this space, I'm going to end on a research, you know, topic, and it's totally research. If there's basic research in energy modeling, this is an example which is what are the returns to complexity in modeling adaptation strategies for the energy system?

So an example I have in mind is that long-run climate scenarios, including NASA and more complicated models, hourly resolution of the system in the late 21st Century.

So the question is: For decisions you're making in the next 20 or 30 years, do you need hourly resolution in 2070 or 2080? How much will it -- how much of a difference will it make to identifying the critical decision thresholds where you want to make long-term -- you need to make long-term decisions about investments at a particularly time?

So better tools for exploring this, I think, would be very useful. And I have in mind the boundary currently emerging between integrated resource planning that's coming back in California and long-run scenario analysis for the energy system that's being done. Those are both becoming more complicated. The critical resilience decisions with respect to climate change are going to be made in the coming decades. And easier ways of making those decisions robustly are more useful tools for identifying those, what those are, in a robust way I think would come in very handy. But this is sort of a long-term and speculative path of research.

But thank you.

MS. RALFF-DOUGLAS: Thank you.

And last but not least, we have Geoff Danker of Southern California Gas Company. And his presentation on Risk Assessment of Climate Change Impacts.

MR. DANKER: All right. Good afternoon. The last panelist on the last panel.

So I'm Geoff Danker, Franchise, Fees and Planning Manager at SoCalGas. I'm here to talk to you guys about our Risk Assessment and Mitigation Phase filing that was recently done to the CPUC last year, so we call it ramp filing, and specifically, the climate change adaptation portion of that ramp filing.

So the purpose of this chapter was to present the Adaptation Assessment and Mitigation Plan for SoCalGas for the safety-related threats to gas infrastructure posed by climate change. And then ultimately coming out of that was addressing the risk through formal planning and adaptive actions.

As we all know and as has been discussed today, each community can be effected differently from climate change. So formal planning and adaptive actions are needed to address changes on a proactive basis. And so we're pushing forward

with the vulnerability assessment and an adaptation plan of our own. And so I'll talk about that later and on our kind of mitigation steps.

So SoCalGas and our friends at SDG&E take compliance and managing risk very seriously. So this is the first time that the utilities have presented this climate change adaptation ramp filing, so please be gentle. The process and outcomes are, of course, expected to evolve through work with the CPUC and other stakeholders over the next several general rate cases.

And so, essentially, the first step was understanding the risks. And so we got a group of subject matter experts together at the Gas Company and did a literature review. And to my surprise is there wasn't a whole lot of data out there specifically related to underground gas infrastructure, and specifically related to climate change impacts to that underground infrastructure. But I think there's an opportunity.

SoCalGas is the largest natural gas distribution and transmission utility in the country. We've got 20 million customers. We go

from Mexico to Fresno, and everywhere in between. And so we have a whole suite of different climates and different potential impacts. And so I think we should be the leader on this issue nationwide. And I think there's a fantastic opportunity for us to start looking at these issues that could ultimately help a lot of other underground gas utilities throughout the country.

So starting at referring back to what our friend at PG&E said, I support this idea of a clearinghouse of data. You know, as I was trying to dig up as much stuff as much stuff as I could find, I was looking at Hurricane Sandy examples, I was looking at the gulf examples, I'm sure we'll have some studies coming out of Houston in the upcoming years, a clearinghouse would be so helpful, just a one-stop shop for utilities, public agencies, the public, somewhere where we know the data is solid, we know it's been peer reviewed and it's accessible. So I'm glad PG&E brought that up earlier.

So we started a process of trying to identify key threats and, of course, around the five major categories of the severity or increased frequency and severity of storms, so

things like El Nino events or heavy rainfall, sea level rise where we looked at coastal flooding, change in precipitation patterns and drought, and so we looked at subsidence and landslides and mudslides, changes in extreme temperature which we looked a lot at increased electric generation and demand for natural gas during those extreme heat days where people are using a lot of air conditioning, and then the increased wildfire frequency, and ultimately the potential for exposure of underground pipelines.

And so after identifying those kind of main themes, we kind of dug down a little deeper and looked at kind of what the related events and, ultimately, the consequences would be? This is still, like I said, at a very high level. This was very much a bunch of SMEs, or a bunch of subject matter experts, using the data that they had available and their experience with their particular expertise areas. And so we looked at, you know, damage caused by flooding and mudslides and wildfires and what that would do to asset repair and replacement.

The same thing for asset repair on the changes of sea level and flooding. We looked at

localized system outages where, you know, increased maintenance for frequently run assets, increased customer usage in capacity-constrained areas, safety shutoffs and emergency fire and flood and landslide events.

And then, ultimately, also looked at policy revisions, so the potential for evolving regulations and standards, as well.

So in order to prioritize or, quote unquote, rank these different risk -- these different risks, we used what we call a risk evaluation framework which, we agreed, was kind of a rational and logical and common framework used to understand and analyze risk. This framework, we called it REF, the risk evaluation framework, the Commission adopted it as a valid method to assess risk for the purposes of this ramp filing, and so we went with it and we used it.

And so, essentially, there was kind of three main inputs into the calculation or the formula where we had a weighting of different impact areas. And we gave a greater weighting to safety and health and environmental, and then a little bit less of a weighting to the operations

and regulatory and financial. And then, ultimately, multiplied that by the level of impact, and ultimately multiplied that by the level of frequency, and then used that to ultimately calculate risk scores for these different risks. And like I said, this is early in the process. And so we plan on working through this is in the next kind of several general rate cases. But it was a very productive process to kind of try to quantify things that are difficult to quantify.

And so looking at how we actually did that, I have this massive matrix that's totally easy to read. But essentially you have your areas on the left that show the health, safety and environment, the operation and reliability, the regulatory, legal and compliance, and the financial. And then, ultimately, with the work of -- with the subject matter experts, we attempted to score the severity of the impact, and then also the frequency or the likelihood of the impact.

And as you can see, for health safety and environment, on the impact, you know, there's the catastrophic level on the far left where there's

a high score of seven where you're talking about fatalities and life-threatening injuries and irreversible impacts to the environment. And then you kind of move down the scale to that where you're talking about, you know, maybe some injuries but no deaths and, you know, minimal environmental impacts.

And so same thing on the operations and reliability where the catastrophic of the extreme scores would be, you know, those types of events that are effecting over a million people, you know, a potential disruption of service for a long period of time. And you kind of work down your line to the lowest score would have been, you know, an impact to maybe less than 100 people and a disruption of service for maybe a few hours.

And then on the frequency scale, you can see the high scores were essentially those items with the potential to occur ten times or more a year. You know, going to the middle where, you know, maybe it's once every three to ten years. And then the lowest scoring on the frequency being, you know, once every 100-plus years.

So ultimately we had an equation that

multiplied the severity of the impact by the frequency of the impact to help us kind of prioritize these different impact areas.

So moving forward, we're using this matrix or this REFF, this risk evaluation framework, to help us kind of prioritize investments moving forward. And we're going to work through this in the next couple kind of general rate cases, that we kind of wrap our heads around what are ultimately the threats to the underground gas infrastructure and where we should be -- where we should be focusing our limited funds.

But the exciting thing for me is something that I'm very passionate about is as we're moving forward with the Gas Infrastructure Resiliency and Vulnerability Report. And, you know, I had to modify my presentation right before this because it's not official-official, but we're close to entering into a contract with a consulting firm who's done a lot of work with our system company at SDG&E on this stuff. And so we're very excited to kind of put pen to paper and get a vulnerability assessment, like our electric IOU friends have done with their DOE

partnerships. And then ultimately using this data to communicate at the local level.

And so, as we all know, SB 3079 (phonetic) has been talked about all day. And so we're looking at developing a tool or process for local government coordination. You know, we've got 250-plus cities. We've got 11 counties. We've got several MPOs. And so we need this data to be accessible. We need it to be easy to understand. We need it to be malleable so we can differentiate Santa Monica from, you know, Riverside and everywhere in between.

And so I included a couple of other specific mitigation things that came out of our ramp filing, but I'm getting the sign that I'm out of time.

So thank you very much.

CHAIR WEISENMILLER: Thanks. Actually, great panel. Some follow up.

I guess I'll start with Melissa on the easy questions, at least the forewarned questions are on forestry access and hydro licensing.

MS. LAVINSON: Okay.

CHAIR WEISENMILLER: Yeah.

MS. LAVINSON: So I think I know your

question on forestry access. And maybe you can just clarify --

CHAIR WEISENMILLER: Yeah, start with that.

MS. LAVINSON: -- on the hydro. So we'll start with the forestry.

So that has been an issue for us in terms of accessing rights of ways and sort of adjacent lands. It's been kind of hit or miss with the various federal agencies. We have worked with Forest Service. We have worked with BLM. We have worked with National Park Service.

I will say, with Forest Service, it has been challenging over the years. But as a result of drought, for the past couple years, we entered into some emergency agreements, we have, as well as Edison, figuring out how to actually take a regional approach to accessing forest land, but they've been upped year by year. We just re-upped again.

But once the year ends, essentially, the requirements around how we can access those lands becomes very challenging. So instead of just giving a notification and doing sort of a regional process of this is the kind of work

we're going to have to do, this is how we'd like to do it, this is how we'd like to access it, let's kind of take a regional approach to this, and creating a notification system as opposed to an approval system, we'll go back to the approval system where it can take, you know, forest by forest, depending on kind of how the forester essentially addresses. The process can take many months to, essentially, just get on and do the work that we know we have to do.

So we're trying to move to a similar kind of arrangement with BLM, given that we had years of drought, and now we have a lot of overgrowth, we haven't worked that out.

And for National Park Service, we're challenged there. Basically, all of the existing agreements that we had with them have all expired, and we're having challenges re-upping them. And I think part of the problem we're going to have going forward is most of our federal agency friends are going to continue to be resource constrained. So even though we have cost sharing agreements with them, they're having, sometimes, challenges implementing them. And as we see federal budgets decline over time,

we know there are going to continue to be resource constraints.

So these are things that we're trying to work through. There's actually federal legislation that we worked on with the industry that passed the House of Representatives with bipartisan support. And we're looking at trying to do this similarly in the Senate, that would actually put in place processes where it would sort of require regional approaches to accessing rights and ways, because we do think that's a much more effective and efficient way of doing it.

CHAIR WEISENMILLER: Do you have any similar issues with California Forestry? Anyway, I thought I'd try to see.

MS. LAVINSON: I'd have to go and --

CHAIR WEISENMILLER: That's fine.

MS. LAVINSON: -- actually (indiscernible) --

CHAIR WEISENMILLER: Yeah. But if you do --

MS. LAVINSON: -- (indiscernible).

CHAIR WEISENMILLER: -- I think all of us understand that with the climate impacts we're

seeing, that we're seeing more and more wildfires.

MS. LAVINSON: Yes.

CHAIR WEISENMILLER: And certainly the implications of the transmission systems and forestry has got to be front and center in a lot of minds. And so the question of how to act proactively there to reduce the hazard is really critical, I think, for all of us as officials. So if there are ways we can work together with you on that, I'm certainly happy to know how to do that.

I think the flip side is, obviously, you have a large number of hydro facilities which are in relicensing. And at the same time there are climate change effecting them, and at the same time with the expectations for the degree of environmental mitigation is dramatically different than when you were granted those.

So again, where does that stand, getting that part of your system much better from an environmental perspective, but also, presumably, better able to deal with the changing climate?

MS. LAVINSON: So you're absolutely right. And again, the hydro relicensing process

can be a challenging process, as well, and take multiple years. I mean, on average it takes about ten years to relicense an existing project. And so it's something that we actually are continuing to work in trying to advance, actually, changes at the federal level, as well, on that process. And I think some of the learnings from today's workshop and from what we're doing on climate resilience is actually applicable.

So one example of things that we'd like to see changed that can be challenging is use of common models and datasets. So even at that level there's not, sometimes, a common use of datasets and models between agencies, so each can go off and do their own analysis and, as we just heard on some of the modeling, you're never going to get the same answer. So it becomes challenging then, actually, to work through what needs to be done from a mitigation standpoint, so it draws out the process and it takes time.

So you're absolutely right. We would love to get through the process faster so that we can actually get to the environmental mitigations that we need to do. Because in the interim the

project just continues to operate as it has operated for decades. So the delay through getting through a relicensing process actually delays the implementation of the environmental upgrades.

And so we recognize that systems are changing, hydrology is changing, and we have to understand that as we go through the modeling process, but we want to get through that faster. So that's another area at the federal level that we've been working to try to advance changes over multiple congresses to better align agency work, to better align the stakeholder process, and to actually move through it at a much faster pace.

CHAIR WEISENMILLER: Now I guess one of the things that I'd certainly encourage you in your written comments is to flesh out better how we can get to the clearinghouse --

MS. LAVINSON: Uh-huh.

CHAIR WEISENMILLER: -- and what we can do in terms of governance in the process.

It seemed like one of the areas I wanted to explore a little bit was, obviously, Edison was very comfortable with, you know, the federal approach we've had, you know, the working

approach with the, you know, agencies on climate.

And the question is: Should we have not just that, but sort of a specialized California version that pulled more generally across the California utilities?

And so that can help with some of the things you've talked about in terms of trying to leverage research better or coordinate research better and to have, you know, just more better understanding across the agencies?

MS. LAVINSON: Absolutely. I think that would be great to be able to replicate something like that at the state level.

Again, I think getting back to the issue of it's good for us to all, I think, be working from similar, again, similar datasets, similar modeling platforms and understanding at the end of the day, what are the objectives that we're trying to hit, and working back from there to then create the metrics to make sure that as utilities, we're actually doing what both we think we need to be doing to mitigate risks, but also what's going to be responsive from your perspective, from the PUC's perspective on that.

So, yes, we think replicating and convening something at a statewide level, because, as we know, the impacts of climate change are very localized. And even within the state, impacts of drought are going to manifest itself differently in our surface area, versus Edison's, versus San Diego. So we absolutely think that that kind of convening, and then that kind of granularity, would be really helpful.

COMMISSIONER RECHTSCHAFFEN: Can I just interject and ask Louise, are we in the process of already establishing this clearinghouse under SB 259? Are we already doing what Melissa has suggested?

MS. BEDSWORTH: Yeah, I mean, to a degree. So through Senate Bill 246 we --

COMMISSIONER RECHTSCHAFFEN: 246. Sorry.

MS. BEDSWORTH: -- were tasked with creating a clearinghouse at the state level, and it's not up yet, there's a placeholder. But we're working closely to tie it -- link it up with Cal-Adapt and make them really work together. Through the direction in legislation, it will include case studies, resources, links to data.

And so we are going through a process right now. We've been doing some stakeholder engagement, user needs assessments. I believe, and I'm going to look to Susan, that we are also going to link up a user needs assessment with an upcoming Cal-Adapt workshop, as well, just to try to tie into the people who are using this information.

And so I think it is a great resource that we can work collaboratively on to build out the body of information in there, because that's always the biggest challenge. I think we have a good approach to thinking about and are facing all of that, but how do we get that credible, updated information in there?

And so we have had a lot of focus to date, really, on local government workers, but also state agency users, of such a clearinghouse. So it's just a conversation we should continue. We're working with a group at UC Berkeley to build that out, actually the same folks who built Cal-Adapt, so that we try as much as possible to have them work well together, so --

COMMISSIONER RECHTSCHAFFEN: And could I ask another follow-up question, and maybe Guido

or Susan or you, the third bullet about better coordinating research so that the utilities are engaged. This is a process to engage the companies in resilience research before we award state research grants to make sure we're not duplicating what the energy utilities are doing in their research. Are we doing that in the Fourth Assessment or in the research, Climate Action Team, or do we have a process in place for that already?

CHAIR WEISENMILLER: Let me try a little bit.

So, obviously, the forum for us is the Investment Plan. And we did a workshop specifically, I'm trying to remember if it was one or two, specifically on climate research there. And actually, I don't know, I was going to say at least I know Melissa was in town for that and testified.

So that's part of the way to try to get that in, although I'm sort of trying to push a little bit in terms of saying, as you can tell, I have a lot of scientists who want to do actionable research, and at the same time making sure that there's a lot of cross communication on

what are the priorities and needs?

And, you know, as I said, we try workshops. We try various things. But if we need to do better, let's figure out a way to do it; right? You know, and -- go ahead.

MS. LAVINSON: I was just -- I'm trying to remember back, because there was, I think, a study that you all funded that looked at some subsidence-related issues in the gas system. And I know the work had already -- there was a lot -- there was research that had already been done, but then there was an engagement with our subject matter experts with the researchers prior to the publication of that. And I think it actually wound up making the publication much stronger because we were able to actually kind of go back in and take a look at some of the information and the data that was being used and update it and make it more relevant to actually what was occurring. So we kind of got in the middle of the process versus, you know --

CHAIR WEISENMILLER: Oh, no --

MS. LAVINSON: -- versus at the end.

CHAIR WEISENMILLER: That's good.

MS. LAVINSON: But I'm thinking if that

was -- you know, if we took a step back and had replicated that a bit at the beginning of the process as opposed to kind of in the middle of the research, that would have even, I think, made for a more robust and actionable output, from our perspective.

CHAIR WEISENMILLER: No, that's good. I think one of the things, looking at my staff, is that often times we have a review group as part of a contract -- you know, but I was going -- hoping someone could direct me if I get too far off track -- but in terms of scoping it, and then as it goes along in the process and the final review.

So if, certainly, we can have your best folks on those committees, along with PUC folks, it's going to make everything much more actionable as we go forward; right?

Guido, please, or David.

MR. FRANCO: Yes. And one of these that we have to use, public process, always, when we talk about research projects. And sometimes it's difficult to talk about nuances and things in high level of detail, and I think we need to find a way to do that with the utilities. I think

we're moving from research that highlights the problem to research that has to inform the solution and help with the solution, with implementation of solutions. So it's a different type of research now, in my opinion.

CHAIR WEISENMILLER: Okay. But let's --

MS. RALFF-DOUGLAS: We had a meeting in March where we talked with the utilities, the PUC and the CEC on some of the issues that were coming up as part of the EPIC and as part of the Fourth Assessment and ways that we thought would improve the process and bring the utilities in earlier in the process.

CHAIR WEISENMILLER: That's good. Yeah, let's work on fixing that.

I guess the other thing you and I have talked about before is this question of, obviously, you're coming up with plans now and, obviously, if we can get the -- you know, for what to do, you know, more on the capital venture side. And if we could get, you know, obviously, the basic underlying science lined up, that's good. But at some point the PUC is going to have to decide guidance-wise, you know, how far are you going to go? I mean, there's obviously a lot

of skepticism amongst some folks that the utilities tend to go gold plate things, have the biased towards increasing their rate base. But it's going to be a very difficult challenge for the PUC balancing costs versus risk.

COMMISSIONER RANDOLPH: Yeah. I was very interested in Craig's presentation about the cost benefit. Because the way you're looking at it, it is similar to the way we're looking at safety issues now in the sense of it's not about -- well, it's not just about following the rules, but it's about do you have a management culture, do you have an organizational framework that fosters safety in a utility? And looking at do you, when you're building a resilient utility, do you have the management structure in place to do that?

And some of what we have to look at is the gap between what does it take to create a resilient utility today under today's conditions, which may have some of the same impacts that climate change will effect, but just less frequent and less severe; right?

So you go, okay, you know, we go to the Cleveland National Forest, we harden the

infrastructure because we know wildfire is an issue today. But, you know, maybe it's not quite so much farther of a jump to anticipate what the wildfire risk would be 50 years from now under climate change because you're going to be physically doing some of the same things, and it's identifying that gap. And so when you're looking at expenditures and you're sort of having that weighing of, you know, is it being gold-plated or not, is it addressing both today's risks and the risks that you're trying to identify going forward, and the gap, you know, may or may not be quite large.

MR. ZAMUDA: If I may, may I suggest, I think one of the challenges that kind of address the accusation that some may have in terms of gold plating is the inverse, and that is to figure out a way to incrementally build upon your resilience so you're making decisions today, perhaps based on the more immediate certain threats that you envision, but you're leaving the capability to leverage that current investment with future investments in the future.

And so kind of an illustrative example would be sort of you're going to be build a

seawall. It's a question of how tall you build that seawall. But if you construct that in the fashion where you can always incrementally over time heighten that wall, whereas you may not want to build it to some higher level today based on a number of considerations and reactions from the ratepayers, it gives you that option of having a resilient, ready solution so that you incrementally improve over time.

So I think looking at it from that perspective so that you don't have to make that total commitment today for what may be uncertain projections over the next 50 years, but you're doing what needs to be done today and leave you the capability to build upon that as you move forward.

COMMISSIONER RECHTSCHAFFEN: Can I follow up on that? Because that gets to sort of a question from Alan, his presentation, and the larger question I had.

What you just described, does that fit into a cost -- does that fit easily or at all into a cost benefit framework or the cost benefit framework that you're using? Because, really, what Alan's presentation highlights is how ill-

suited, in some ways, climate change is for a traditional cost benefit model? When there are massive uncertainties and catastrophic, unimaginable risks that we can't predict, how do you put that into a traditional cost benefit analysis?

So that's -- the Chair pointed out one end of the spectrum. You're on the other end of the spectrum. And we have to figure out how much spending makes sense --

MR. ZAMUDA: Right.

COMMISSIONER RECHTSCHAFFEN: -- to deal with what set of risks when.

So I'm wondering, are you grappling with that in your cost benefit --

MR. ZAMUDA: Yeah. I'd say that it's --

COMMISSIONER RECHTSCHAFFEN: -- methodology?

MR. ZAMUDA: -- it's the proverbial, the best is the energy of the good; right? You have to make decisions today, so you can't wait for that perfect dataset, for all the uncertainty to be removed, et cetera. You can't wait that long, so decisions are being made today. So what's the best decision you can make today with the

available information that's out there?

And so what we're really trying to do is to kind of recognize those uncertainties and do what's responsible in terms of investments, but not to defer those investments and pay the consequences; right? So we either pay now or we'll pay later.

The real question is: What should we be doing? What is a prudent kind of no-regrets investments to be making today that leave us the option to deal with that uncertainty into the future so we can kind of come back and revisit that as we're moving along?

So I don't know if that's responsive to your question.

COMMISSIONER RECHTSCHAFFEN: Okay.

MR. ZAMUDA: But I think there are a number of solutions that we can also identify in terms of how people are currently dealing with that uncertainty. I'll give you one quick example.

Public Service Electric and Gas in New Jersey, coming out of Superstorm Sandy, they were in this situation, proposing resilience investments. And they had to justify what was a

prudent investment. And so what they turned to was this kind of break-even analysis approach where they looked at what would be the cost to certain investments they'd want to put in place, and then how long would an outage need to be to justify that cost?

So just for lesser purposes, if you're talking about a substation was flooded, and now they're going to elevate that substation, replace that substation, what would that cost? And then they looked at how long would an outage need to be to recoup that investment? And what they realized was that, in many cases, they were talking about an outage of over two or three days would more than pay for that investment. And when you looked at a storm like Superstorm Sandy, although one may say that's 1-in-100 or 1-in-1,000, the outages went on for days, if not weeks. But that's just one event.

And so what they were able to do is without necessarily at a fairly quantified level predict the future, they could kind of use common sense parameters and recognize that even in the absence of a 1,000-year or a 100-year event, they were going to see outages which this investment

would address. And so using that kind of break-even approach, it's kind of an alternative variation on cost benefit methodology, they were able to justify those investments.

CHAIR WEISENMILLER: Yeah. I wanted to ask you, I mean, obviously, are you going to be doing any lessons-learned studies on like Houston or, you know, on Sandy? I mean, obviously, all of these are sort of various things. So in terms of really diving into some of the relatively catastrophic things that have occurred elsewhere, lessons learned might be, again, some way we can get some guidance --

MR. ZAMUDA: Yeah.

CHAIR WEISENMILLER: -- going forward.

MR. ZAMUDA: Well, I think I'll use an example of Superstorm Sandy.

CHAIR WEISENMILLER: Right.

MR. ZAMUDA: I think Superstorm Sandy was a real poster child in terms of demonstrating some of the issues that we need to be looking at in terms of resilience, not just the examples of the cost benefit methodologies we can use to justify investments, but even the cascading impacts, interdependencies of electricity with

the rest of the energy sector, with other sectors, to recognize that we need to look at this from a holistic perspective.

So when the electricity went out and the wastewater treatment plant couldn't operate and millions of gallons of untreated sewage were being dumped into the waterways, or when the electricity went out and gas stations, because they need electricity to drive the pumps, couldn't provide gasoline, even though they had it, or you can kind of go down the endless list of looking at these interdependencies, and the lessons learned that we achieve coming out of that example.

And I'm sure Hurricane Harvey will provide us additional fodder in terms of helping to characterize what we may need to be doing different in terms of resilience, and not looking at it from a perspective of, oh, that's just 1-in-a-1,000-year event, but recognize the frequency, intensity and duration of these all events are coming a lot faster.

So I think last time I was hear I kind of paraphrased it, oh, you'll be (indiscernible), the future ain't what it used to be. And we need

to prepare, in terms of a decision making process, to address that change that's taking place.

CHAIR WEISENMILLER: You know, our colleague at the Office of Emergency Services, one of the things they're focused on is like a 18-day outage, you know, looking at, I'm trying to remember, whether it's Tennessee or Kentucky, but this series of windstorms that just knocked out all the power in a substantial area for 18 days, which then sort of rippled through all, you know, water, you name it, going around.

And so certainly there can be, you know, some fairly catastrophic things which normally we don't think are ever going to happen but can happen.

MR. ZAMUDA: Can I make two other comments --

CHAIR WEISENMILLER: Sure.

MR. ZAMUDA: -- with regards to an earlier question that you had, talking about- the clearinghouse.

I just wanted to highlight the fact that at the federal level, at the national level, we

recognize that same need for that information. In fact, there was a clearinghouse that was established in the last administration, it was a climate resilience toolkit. And I'll suggest that there is an ongoing emphasis being placed on addressing that need. And there may be some synergies between what you want to do in California and what has been in this ongoing effort out of Washington D.C. And if there's points of contact you need for that, we can certainly provide that.

Similarly, on the partnership, we recognize the need. In fact, the utilities recognized the need and they came to us a couple of years ago to kind of stand up to the partnership. We recognize that not only is that a value at a national level, but comparable entities probably need to be established at a state level, or perhaps a regional level. The State of California is somewhat dependent in terms of energy being imported from other states, so you're all in this together, and kind of looking at replicating that idea of partnerships and greater collaboration.

And sharing of best practices is an

excellent idea. I would like to see it both at the top level, national, state level, and all points in between. Anything we can do to kind of help support that and have some synergies in terms of that exchange of information, we would welcome.

CHAIR WEISENMILLER: That would be good. Well, obviously, I was disappointed not to see WAPA, nor BPA, participating in your effort.

MR. ZAMUDA: We are looking to mature this partnership as we move forward. We have a limited set of partners currently that are participating in this. By design, we wanted to keep it small to kind of maximize the degree of networking and communication that could take place. We're looking at opportunities to expand that composition, as well as, perhaps, looking at moving beyond just climate resilience and other aspects of resilience, as well. So there's, you know, a revisiting going on after two years of this partnership to see what we can do to improve and build upon the success that we've had to date.

CHAIR WEISENMILLER: Thank you.

Louise, you've been trying to figure out

how to build in the state's capital process, you know, investment process someway, really building in, you know, considerations of, you know, adaptation and climate change. And I was trying to figure out, just in terms of are there specific approaches or tools that might be useful to build into the PUC -- or into the utilities investment processes?

MS. BEDSWORTH: Yeah. I mean, I think we've been reviewing for several years the state's Five Year Infrastructure Plan and looking at the integration of climate change into that. One thing we've done is created a checklist that is just sort of a screening tool that accompanies budget change proposal requests for infrastructure, so that's one element.

The other, though, that I think was really interesting this year is every two years, all departments that own or lease facilities create a sustainability roadmap. And that was to look at meeting the governor's executive orders around energy efficiency and zero-emission vehicles and water efficiency. And this -- they're in the process of updating those right now. And so we added a climate resilience and

adaptation element to the sustainability roadmap. And we worked with our Department of Technology to use the new API and Cal-Adapt's 2.0 to pull in climate change baseline data and climate change information for every owned and leased facility that state departments have.

And then we walked through a process of how do you interpret and think about what that information means? So if you look at all of your facilities, which ones have the highest risk from extreme heat change or changing precipitation? And that was actually a really informative process, I think both for thinking about how we use Cal-Adapt, for thinking about what parameters are helpful and which are maybe less so, and just walking through that process with the department facility managers. And so that's still an ongoing process but that has been another, which is, you know, really to just start bringing that climate change information into the processes that we're -- you know, and decision making, you know, just making it accessible.

And so I think that's a great feature of the update to Cal-Adapt, is the ability to pull that information in. And, of course, we have a

lot of work to do on how we help departments work with it. But I think that was a first step that was pretty valuable.

If I can, I'll step back, also quickly, to a question Cliff asked on the cost benefit analysis question, and I think touches on what Alan talked about. And I kind of rushed through it, but what we tried to do was use those characteristics of sort of the risk, the scope and scale of risk, to also talk about how you choose an analytical approach? Because we do have departments that have been using robust decision making which is very -- it's fairly resource intensive and complex.

So what we tried to do was say not everybody needs to do this. In some instances we do need to do this, and how can you think about the characteristics of the risks that we're facing to also inform the choice of an analysis approach? And where do we need to step into these new methodologies? And where can we maybe, you know, do something that is a little bit more, I don't want to say back of the envelope, but is a little bit simpler and is just a starting point?

And so I think we tried to address, for

state agencies, not just the what are we planning for, how do we plan differently, but then, also, how do you inform the selection of an analytical approach, and where do we need to move into some of these other approaches to addressing deep uncertainty?

CHAIR WEISENMILLER: That helps.

Just to follow up, I was going to ask Geoff and Melissa in terms of your willingness to try what Louise is trying to do with state facilities for your facilities?

MR. DANKER: You want to start?

MS. LAVINSON: Sure. I mean, I think that's part of what we're actually trying to do in starting to get up and running. So that's part of the work we're doing around the visualization maps to actually, right, take the modeling that we're doing, superimpose that kind of over our systems to understand, actually, what are the potential impacts, vis-a-vis existing assets.

And then going forward, as we're looking at, you know, future investments, trying to create what would be a useable climate resilient screening tool for our Operations Team as they're

looking at making future investments, we want to pilot this, so we're going to target it at creating enforcement of the more, you know, expensive projects, right, those investments that are sort of $20 million or above, to ensure that as people are going through the process of, you know, going through their checklists of what they're looking at, that they're recognizing whether the potential impacts, not just today but 10 years, 15 years, 20 years out, potential climate impacts.

And so it's not just sort of what is the risk of that asset to wildfire, but what is the risk to that asset if you impose, you know, years of wildfire, followed by, you know, followed by heavy rains, followed by drought, followed by et cetera, what then are the actual then multiplier effect that could happen? And now when you look at that asset, is that the right asset in the right place, you know, at the right time? And so that's the approach that we're taking, and we're in the process of doing that. We're working with our business alliance to do something that's useable and user friendly and that can actually integrate into their existing process. So we

haven't done it yet, but we're in the process of doing that now.

MR. DANKER: Yeah. And we're king of agreed. We're at the early stages of -- this ramp filing was a good first step for us. And then working with the consultant to help us expand on that into a systemwide vulnerability assessment to ultimately be able to kind of hone in on more specifically what the impacts would be and the sort of infrastructure investments that would be necessary. And so we're noticing that we kind of have specific analysis to specific requests, either from the CPUC, and so, you know, we'll have a specific El Nino study that looks at a specific area, or a some subsidence work in the Central Valley that looks at drought. But being able to synthesize that systemwide and to kind of be able to compare things side by side is definitely something we're working on.

CHAIR WEISENMILLER: Yeah. And just following up with Alan for a second is just, obviously, you've laid out the complexities of trying to do the decision making here. At the same time, it's pretty clear, the PUC is going to be running into these issues more within, you

know, a couple years. And so just as Louise was trying to figure out how to provide some guidance, you know, how to bring in better than nothing but realizing it wasn't going to be to the ultimate level, what are your suggestions on how to at least start bringing in some of that into --

MR. SANSTAD: Yeah.

CHAIR WEISENMILLER: -- this thinking?

MR. SANSTAD: So I want to -- a couple of things.

First of all, I think Commissioner Randolph's example is very well taken. I mean, in this example, what you were just suggesting, what Craig was both -- also suggesting is heuristics; right? I mean, you have enormously complex, enormously uncertain situations. So what are relatively simple rules you might follow, you know?

So, for example, if you were going to harden some infrastructure now anyway, maybe a little more in anticipation of the possible future impacts and, if so, how much more, or no-regret strategies; right?

So I think of an avenue forward, because

he's obviously right, you know, you have to do what you have to do now with the tools you have available. I think it's identifying those situations where you can apply those rules of thumb in a well justified way. And I think, like I was very impressed with what Louise said, when do you really need to get more fancy; right? I think identifying those situations, making those distinctions, is extremely -- I hadn't actually thought about it that way before, but that's a very important thing because these things are resource intensive.

But I'll go back to saying, what is the essential information; right? So, for example, you know, the no-regret strategy, no-regret decisions are great when they're available. But what is -- what are the right ways to hedge to buy yourself time? And in terms of what I think are the high -- the critical ones are where do you get beyond a point of no return, where you have to do something now, and if you don't do it now you face a very high risk later. How do we identify those things? And that has -- that all has a lot to do with just literal climate impacts.

Mr. Freeman from PG&E had a term earlier today about non stationarity, right, so designing things for 1-in-10, 1-in-100, 1-in-500. Well, how often 1-in-100 things are going to occur is changing in ways we don't know. So looking at the phenomenon and figuring out what are the -- where are the sensitivities to the system for resilience measurements to those kinds of standards; right? And how reliable do you want it to be? Because no regrets, and also designing for the worst case, are both not very -- not going to be applicable very often.

So, I mean, I'm sort of thinking out loud here. But I think practical steps and, you know, common sense is very good.

I do think, as (indiscernible) said, extremely complex systems and methods in certain -- may or may not buy you what you need in these cases; right? So I like the idea of heuristics with available evidence before you jump in and try to model everything more complexly, and then see what comes out of it, you know, deciding what information, what is the critical information you really need to make a particular investment about an infrastructure

item or resilience.

There's another issue here that we haven't even touched on, is what are the regulatory standards of evidence for doing this; right? And that's -- I don't have much to say about that, but it's clearly a very important problem about, you know, this is making -- under risk is hard enough. This is making it under uncertainty, and how you justify those investments in an IOU is another frontier, but --

COMMISSIONER RANDOLPH: And I think the flipside is also true in the sense that you -- we have to, in a time of uncertainty, have to decide what expenditures not to make, right --

MR. SANSTAD: Correct.

COMMISSIONER RANDOLPH: -- and, you know, physically where to put an asset or how to modify a planning decision based on, you know, imperfect information going forward.

MR. SANSTAD: Right. So I think, you know, to, you know, recap one thing I called out is, you know, a critical threshold, right, when you have to make -- when are you going to have to -- when are you going to have to make a decision that you can't undo later, right, or

when are you going to have to make a decision that you can't delay anymore, and where are those thresholds? I think that's the type of, you know, better information, about that specifically, would be very useful in moving toward more robust decisions.

CHAIR WEISENMILLER: Thanks a lot. Thanks for being here. Let's go on to public comment.

MS. RAITT: So I didn't receive any blue cards, but we are -- it's time to move on to public comments. I don't know if there are folks in the room who wanted to make comments? All right.

Go ahead, I think. And just please identify yourself.

MS. AVE: Hello. My name is Kathleen Ave. I'm with SMUD's Energy R&D. I manage our Climate Program. And I also chair our Regional Climate Collaborative. SMUD is a member of the DOE partnership, as well.

Because I have three minutes, I'm going to narrow my comments tightly.

We also have a forest health research project underway, a paired catchment study that

we're trying to scope right now and would absolutely love to see the CEC and the CPUC focus more resources on the bridging of remote sensing techniques with on-the-ground assessment techniques, as well as working on more coordination with federal agencies and private landowners that can create obstacles to that kind of research.

It wasn't mentioned today, we also have a new study we're scoping to look at biosequestration potential in our region because it has so much mitigation and adaptive benefit potential. It's an area that is a fairly technically heavy lift initially. We're working with the Nature Conservancy, with some of the past work that they've done. But that's an area that I think, especially since it's a pillar in our state's Climate Strategy, would really benefit from additional state focus.

But I want to focus my comments on urban heat island. It's been discussed today. It has been a focus and very well-known phenomenon for many years. But I feel like there are very few places where there's the ability to take a heat reduction goal. And because there are so many,

you know, multi-sector impacts related to heat, in Sacramento for example, we already have in excess of the state average in heat-related illness and death, there's a big nexus with the energy sector, but there's so many impacts, there's no one place, no one entity that can really take on an initiative like that. Our Climate Collaborative has done so. Los Angeles has taken a heat reduction goal.

But there is a need for more follow-up research to the urban heat island index work that was done by CalEPA a few years ago that identified sort of the hotspots and the heat archipelagos in certain regions, but that was limited by population density. And it doesn't show you where you can best target mitigation. It shows you where to send the ambulances in an heat event, but not really where there are the most effective places for interventions. And this is an area that, you know, it's ripe for real focus to reduce urban heat island and equalize some of that as global temperatures warm with what's in the system. And, you know, it sounds like it's an overwhelming problem, but roofs get replaced every 30 years, pavements get

restored multiple times within that time frame, so -- and it's entirely human caused, we know that. It's a great area to really focus on improving health and economic vitality.

And I'll just close with a mention of that recent UC Berkeley study that came out that indicated that for every -- well, it was by county -- indicated that for every degree Celsius increase in Sacramento County a four percent hit on the county's domestic product, a four percent hit to the economy. And when we're talking about a four degree C increase by mid to end of century, we're talking about nearly 20 percent of the economy as a result of heat. So that needs more focus, and there are some examples from around the country of studies that could be done by the CEC to help regions along that path.

Thank you.

CHAIR WEISENMILLER: Thank you. I'd note that SMUD's been a leader in this area for a long term, certainly. And you have had, I think, a workshop every single year on climate issues, including adaptation. And obviously SMUD testified at some of the earlier events. You know, we're certainly looking forward to your

written comments.

But anyone else in the room, on the line?

MS. RAITT: I don't think we have anyone on WebEx, but we can go ahead and open up the phone lines. So if you wanted to make a comment and you're on the phone, go ahead. And if not, please mute your line. It sounds like we don't have any comments.

CHAIR WEISENMILLER: Okay. So you're going to remind people when written comments are do?

MS. RAITT: The written comments are due September 12th.

CHAIR WEISENMILLER: And so in terms of now on the dais, again, I want to thank everyone for their participation today. It's an important topic. I think we covered a lot of ground. And I thank the staff for the organization of the workshop. This came together well.

I would note that Laurie asked me to -- reminded me that I should also, in terms of utilities participating and shaping the research, I guess we have two buckets. One is one where the utilities plan on competing for the money, and one is where they plan not to. So if you

plan on competing, you can't really be sitting at the table or designing it. But if you're not, which many of these areas, I doubt if you would be, then, sure, come on down.

COMMISSIONER RANDOLPH: I don't have anything else to add. Thanks, everybody, for participating. This was a really useful discussion.

COMMISSIONER RECHTSCHAFFEN: Likewise. Thanks, everybody, very much.

CHAIR WEISENMILLER: Okay. The meeting is adjourned. Thanks.

(The workshop adjourned at 4:34 p.m.)

REPORTER'S CERTIFICATE

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were reported by me, a certified electronic court reporter and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

IN WITNESS WHEREOF, I have hereunto set my hand this 19th day of September, 2017.

_____

Eduwiges Lastra
CER-915

CERTIFICATE OF TRANSCRIBER

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were transcribed by me, a certified transcriber and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

I certify that the foregoing is a correct transcript, to the best of my ability, from the electronic sound recording of the proceedings in the above-entitled matter.

MARTHA L. NELSON, CERT**367

September 19, 2017