DOCKETED

Docket Number:	15-MISC-05
Project Title:	2015 Bulk Storage Workshop
TN #:	206891
Document Title:	Transcript of 11/20/15 Joint Workshop with the California Energy Commission and the California Public Utilities Commission
Description:	N/A
Filer:	Cody Goldthrite
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	12/8/2015 10:55:50 AM
Docketed Date:	12/8/2015

JOINT CALIFORNIA ENERGY COMMISSION AND

CALIFORNIA PUBLIC UTILITIES COMMISSION WORKSHOP

BEFORE THE CALIFORNIA ENERGY COMMISSION

In the Matter of:	)	
	)	Docket No. 15-MISC-05
Bulk Storage Workshop	)	
	)	

CALIFORNIA ENERGY COMMISSION

1516 9TH STREET

ART ROSENFIELD HEARING ROOM

SACRAMENTO, CALIFORNIA

FRIDAY, NOVEMBER 20, 2015

10:00 A.M.

Reported by:

Kent O'Dell

APPEARANCES

COMMISSIONERS

Robert B. Weisenmiller, Chair

Carla Peterman

ALSO PRESENT

Michael Picker, California Public Utilities Commission President

Stephen Berberich, California Independent System Operator President and Chief Executive Officer

Kevin Barker, Chief of Staff to Chair Weisenmiller

Mark Rothleder, California Independent System Operator

Shucheng Liu, California Independent System Operator

Arne Olson, E3

Michael L. Jones, Pacific Gas and Electric

John Dennis, Los Angeles Department of Water and Power (via WebEx)

Kelly Rodgers, San Diego Water Authority

J. Douglas Divine, Eagle Crest Energy

Fred Fletcher, Burbank Water and Power/Pathfinder

Joe Eberhardt, EDF Renewables

Michael Katz, Advanced Rail Energy Storage

Alex Morris, California Energy Storage Alliance

Neil Reardon, California Public Utilities Commission

Matt Buhyhoff, Federal Energy Regulatory Commission (via WebEx)

APPEARANCES

PUBLIC COMMENT

Jennifer Didlo, AES Southland

V. John White, CERT

Tony Braun, California Municipal Utilities Association

Ed Cazalet, MegaWatt Storage Farms

David Kates, Nevada Hydro Company

Jimmy Nelson, Union of Concerned Scientists (via Webex)

AGENDA

P R O C E E D I N G S

10:03 A.M.

SACRAMENTO, CALIFORNIA, FRIDAY, NOVEMBER 20, 2015

(The workshop commenced at 10:03 a.m.)

MR. BARKER: -- for joining us here at the Bulk Storage Workshop. We're going to go ahead and get started. I have a few housekeeping messages to go through.

Please note that this meeting is going to be recorded on WebEx and it will be available pretty soon after the meeting adjourns.

For those unfamiliar with the building, the closest restrooms are located out the doors that you came in to the left. We have a snack bar on the second floor under the white awning.

Lastly, in the event of an emergency and the building is evacuated, please follow our employees to the appropriate exits. We will reconvene at Roosevelt Park which is catty corner to us on the south side. Please proceed calmly and quickly. Again, follow the employees with whom you are meeting to safely exit the building.

Again, thanks, everybody, for joining us. This workshop is a joint workshop -- oh, thanks -- this workshop is a joint workshop with the California Energy Commission and the Public Utilities Commission.

One thing to note, although it was noticed jointly with long-term procurement policy procedure, the comments that will be -- that you docket under the Energy Commission docket are not -- will not go into the record on the LTPP proceeding. Those have to be filed separately in accordance with the rules there.

So with that I'll turn it over to our dais for -- for opening comments.

Chair Weisenmiller, did you want to start?

CHAIR WEISENMILLER: Good morning. Thanks for your participation. This workshop today is a good opportunity for us to explore a couple of things.

One is to understand some of the potential need for storage with relatively long duration, as opposed to short duration. And the other is to look at our existing pumped storage facilities. California obviously has a massive water infrastructure, including pumped storage, including pondage hydro, and what can we do to squeeze more out of that? And how is being operated now? How can it be used to -- as we have more and more renewables, how do we -- what can we use to really optimize that? So one of the things I'm looking for is how do people use their existing pumped storage facilities, and is there ways we can do more with that?

And then, obviously, there's some proposals for additional bulk storage, including particularly pumped storage. We're going to get some understanding from the developers what the potential issues are.

And then finally, there are -- certainly most of us think of bulk storage as pumped storage but understand a little bit the options in terms of compressed air, et cetera. So anyway, I need to get some wrap up from Staff. This is an area that certainly President Picker, I and Steve Berberich all have interest in, as -- as does Commissioner Peterman. And this was a good opportunity to try to develop a better understanding.

Now having said that, it's also hard to get the three of us together. I think we were hoping to do this awhile back. So certainly we would encourage everybody to very concise because we're sort of running at least a number of different directions all the time.

So again, thanks for your participation. I'm looking forward to an interesting day.

And let me turn to -- I guess I'll go to Steve next, and then Michael and Carla.

MR. BERBERICH: Thank you, Chair Weisenmiller. I appreciate the opportunity to be here today. I would reiterate much of what you said, so I won't do that.

Clearly as the system continues to evolve here in California and we aspire to show the world how all this can fit together, storage is going to be a critical element of that. And we certainly have the opportunity for distributed storage. But I think bulk storage will provide a great opportunity to offset conventional generation in a number of ways, one, from a contingency perspective, two, from a ramping perspective, and three, just from a load management perspective.

So we need to certainly explore bulk storage in earnest as an opportunity to help kind of fit all the pieces together. So I appreciate the opportunity to be here today.

PRESIDENT PICKER: I don't really have a lot to add to what my distinguished colleagues have said. These are generally large projects. They are now in a -- in a much broader market for other types of storage. And so we have a challenge, not only to figure out how we could use these to augment our highly variable resources at -- at the bulk transmission level, but then how they compare for -- with similar choices that would occur in the distribution system.

COMMISSIONER PETERMAN: Good morning. Thank you for holding this forum today. Indeed, we've been talking about the need for different types of storage now for several years, long duration and shorter duration. I appreciate that many of you have been active in the CPUC's Energy Storage proceeding and provided a lot of the commentary as we set the initial targets. And particularly, we had a lot of discussion about the opportunities for pumped storage.

We had a productive workshop, I think, in January 2014, looking at some of the opportunities and barriers to pumped storage deployment. And so I'm interested in learning today.

And then also as we move forward, you know, what are the barriers that still persist? What are ways that we as a commission can help address them? in addition to pumped storage, as my colleagues noted, there are other types of long-duration storage that we need to be considering. In addition to compressed air, there are multiple battery technologies, you know redox flow and sodium sulfur. And so I'm interested in talking about some of the kind of tradeoffs with these technologies. There's also some demonstration projects happening with these technologies. And so I'd like to get more information from the parties and the utilities involved in those as we go forward about timelines.

And then finally, on the point of timelines, I'm interested in a longer-term discussion about the technology roadmaps for some of these technologies and some of the cost projections. Thank you.

MR. BARKER: So we're going to -- we're a little ahead of schedule. We're going to go into our first joint presentation with the California Independent System Operator and E3. I think Arne -- we have Arne Olson from E3, and Mark Rothleder and Shucheng Liu from the ISO will be presenting. We're going to start with E3

MR. ROTHLEDER: Well, let me introduce, first off. My name is Mark Rothleder. I'm the Vice President of Market Quality Renewable Integration at the California ISO. And in my role, for several years I've been responsible for looking at and studying some of the integration needs, flexibility, over-generation potential that is potentially going to happen on the system as we evolve this system and go towards the higher levels of renewables.

Today we're at about 25, 28 percent renewable portfolio standard. And in 2016 [sic] we have about 115 gigawatt hours of dispatch of renewables down from what they could have otherwise produced.

If we look forward we know that at least the 40 percent results of our studies indicate that we were -- that is going to increase to something like around 2,000 gigawatt hours of potential risk of curtailment or dispatch of -- of renewable resources down.

If we look forward to 50 percent renewables there are some projections that that could be 10 percent to 25 percent of the total renewable production itself. And so just putting that in context, we're talking about a significant increase in scale of the potential risk of curtailment or losing that valuable renewable resource that we could do something with. And I think as a result of that the prospect of a large-scale storage resource is a natural progression or natural solution in -- in the context of an assemble of solutions to look at.

And that's where we are today, is that we are starting to look to the value of large-scale storage. This is a work in progress. The work that the ISO has done that Don and Shucheng Liu will be presenting today will be very specific to the 40 percent long-term procurement proceeding studies that -- where we left off last year. However, we are going to progress and move into 50 percent study work going forward. And we hope that early next year we'll have some additional results to present to you.

I'm going to start with Arne Olson from E3 to give you kind of a high-level overview general perspective of the -- the value or the capabilities that storage can play, and -- and then the interplay between those and potential other solutions. And then Shucheng Liu will go into more detail of the specific results of his 40 percent work. And then I'll finish up with where do we go next in terms of the next steps.

MR. OLSON: Thanks, Mark.

Well, good morning. My name is Arne Olson. I'm a partner with E3. And I just want to start off by saying thank you for the invitation to come and -- and talk to this group. I'm really excited to hear all the other presentations today, as well.

So just at a high level, I think we've all understood intuitively that when you get to some level of wind and solar penetration that some form of storage is needed; right? There resource is variable. It produces only during certain times of the year. The sun doesn't shine at night; right? So intuitively at some point we'll need to store sun power during daylight hours and use it again at night.

To date, though, the studies that have been done haven't been really very specific on what type of storage do we need, at what level of penetration, under which renewable generation, you know, portfolios, and at which operating regimes. So I think the next step is to get more specific about, you know, which types of storage do we really need in California over the next, you know, 10 to 20 years. And so I think as a result this workshop is very timely and this effort is very timely.

There's just some examples here on the slide of a couple of previous studies where we've looked at storage as an individual solution, tested its effectiveness and its cost effectiveness. The CERT Low Carbon Grid Study is notable which assumed that we were going to have 7,400 megawatts of storage in place at 2030 at the 55 or 60 percent RPS case that they were testing.

Probably you're all familiar with this graph by now. But as we've studied, you know, higher -- higher penetration scenarios, particularly with lots of solar, we've begun to understand that over-generation and the potential for renewable curtailment is the main renewable integration challenge. This chart shows 33 percent, 40 percent and 50 percent renewables. The red wedge there is the amount of curtailment that you see on this typical kind of springtime day.

So you know, this means -- this has a couple of meanings, number one, that there will be curtailment and we'll need to be prepared to curtail renewables very routinely during the many hours of the year to maintain system reliability, but that also to make this system cost effective we'll need to find a way to use a lot -- a lot of this surplus renewable energy, either exporting it or storing it or finding some productive use for it.

The over-generation -- the real cost of curtailment and over-generation is not the fact that you're not using the energy that's available during that hour, it's the fact that when you have -- when you have a greenhouse gas goal, when you have a production quota like an RPS that you have to go out and replace that energy with something else, like for like. And if we're trying to meet a 50 percent RPS, if I have to curtail some renewable energy then I'm not going to be able to comply with the standard. That means I have to go out and build more turbines, build more solar panels to make sure that I can meet that standard. That's really the cost of over-generation.

And the value of storage, then, is it helps us to avoid that over-generation, helps us to avoid that over-build of the renewable portfolio which otherwise would increase the cost of compliance, would increase the cost of reducing the greenhouse gas emissions.

And so I want to really encourage you to think of the -- the decision framework on storage --

PRESIDENT PICKER: I'm sorry, but I just -- you're assuming business as usual and that no other policy changes come forward in the period between now and reaching that 50 percent penetration. So I'm just going to contest with you to say that over-generation is not our biggest problem. I'll just say that lack of imagination is. And please don't -- don't ever use those terms in my -- in my presence ever again.

MR. OLSON: Fair enough. I'm really just trying to set up the issue for us then to figure out how to tackle it, to use our imagination --

PRESIDENT PICKER: But you -- but you're -- but you're --

MR. OLSON: -- to find the best way to tackle it.

PRESIDENT PICKER: You're putting a frame in here that constrains the range of -- of opportunities. I mean, I could say that we have a great boon here and that's cheap electricity, and what the heck is wrong with cheap electricity? So again, don't do that again.

MR. OLSON: Fair enough.

But you know, what this graph, I think, tries to get us -- get us into thinking about is what the best ways are to use that type of -- that boon of excess energy that's achieved, as you said.

So in the past we've tested various different solutions, various different ways to do that. We found that energy storage can be a cost -- a cost effective solution at -- you know, depending on what you assume about its cost and duration and those sorts of things. We've also found that there are -- maybe are other solutions which are -- which are most cost effective. So I think part of the challenge is to understand which of these solutions and what combinations are the -- are the best way forward for California.

So this brings me, I think, to this latest effort that we’re trying to take that next step and look in more depth at what solutions are out there and, again, what kind of -- the best kind of combinations are, which is renewable integration solution study that we’re working on with the Energy Commission and the Cal ISO using a new model called the resolve model which tests solutions and tries to find those -- those good combinations. I don’t have a lot of results that I can share with you today. But I think I can talk a little bit -- a little bit about what we’re learning about the role of energy storage out of that study, and I think it’s pretty interesting.

What we’re finding is that bulk energy storage can provide really two different types of services. And I really want to encourage you about the services that the grid needs as opposed to the specific technologies that can provide those services. There’s -- there’s a distinction there. There’s two types of services that we’re finding are potentially valuable. One of them is long-duration services, storing energy during times of over-generation and using it, you know, providing it back to the grid at a time when -- when we can use it.

But there’s also a short-duration service which we’re finding is also valuable. And I think this is new and very interesting, which is the ancillary services within our variability is also potentially valuable for storage, but for I think a different reason than we were thinking of before. And really both of these types of services can be provided by multiple different forms of storage, whether it’s batteries, flow batteries, pumped hydro, compressed air.

Let’s see, so this is just an example of how the long-duration service work, you know, we understand that when we have loss of solar energy that we might some excess during the daylight hours. And if you can use storage you can soak up that energy during the daylight hours and then use it again at night when you can displace fossil generation.

The short-duration services are a little -- are different and interesting, if I can get to that slide. It’s just a little slow. In most of the cases that we’ve run at high levels of renewables we’ve found that this service is a relatively low value as long as what you’re -- what you’re doing is displacing fuel at the margin. You know, the -- the fossil generation has to run at a little bit less efficient level to provide more reserves to make sure that the grid can operate reliably. If storage is really just, you know, changing which -- which gas generator dispatches, there’s a limited amount of value to that.

What we’re finding that’s new out of this study is really interesting, which is that during hours of over-generation, that this service becomes more valuable because it allows you to reduce the amount of curtailment. And this example shows that -- let's see, the top line there is the gross load and the bottom black line is the net load, and you can see it's varying all of the place. And this is why you need these regulation and load-following services to meet this variable net load line.

You can during this hour that you also have a lot of curtailment because you just happen to have, you know, excess renewable energy during those hours. If you're using fossil resources to provide those within our reserves, you're having to turn those resources on and run them at above their minimum generation levels during an hour when you're already curtailing renewable energy. So if instead you can -- you can use the renewables themselves or some short-duration storage to provide that service, that allows you to really reduce the amount of fossil generation that's running and to reduce the amount of curtailment that you have during that hour.

So our results now are finding this is actually potentially pretty valuable service depending on how many hours that you have over-generation conditions.

Obviously, the cost of storage is going to be a big driver of the results. If -- you know, we really are thinking of this as an economic issue. You know, we're expecting significant declines in the cost of storage over time, particularly battery storage, pumped storage, the costs are going to be very site-specific, you know, depending on the size of the reservoir, what additional facilities need to be added.

And what we're finding is that the storage that's added in the model, the model will add storage economically to minimize the cost of RPS compliance. And what we're finding is that the type of storage and the duration depends a lot on the costs that you assume and how much of those costs declines are really realized.

So just to summarize quickly on major conclusions that are coming out of our preliminary results, and again these are all really preliminary at this point, which is that in cases where we have a lot of solar generation and not a lot of other solutions added, we're finding that our model is adding a fair amount of dedicated grid storage.

If I could get to the next -- thank you.

We're also finding that implementation of other solutions can delay and significantly reduce the need for energy storage, and these are things like a more diverse renewable portfolio, allowing the renewables themselves to provide some of these within our reserves, enhanced reasonable coordination and other solutions really can kind of substitute for storage and might be a lower cost, at least in the near term.

We're also seeing again from these preliminary runs that some storage is needed to provide these long-duration services at sort of 55 percent RPS and above in just about all the cases. So even when you're -- when you're adding all these other solutions you do need some storage. You might not need it right at 50 percent but you need it. It's kind of just over the horizon, so it's a really important resource to be investigating. And again, the quantity, type and duration of the storage will depend on the relative costs of the different types of technologies.

And the last slide -- oops -- is just sort of our pocket guide that we're working on, pocket guide to integration solutions. At the top is regional coordination. This is a solution that provides net benefits, even in the absence of a renewable integration challenge. There's another category of solutions where there is some cost. It's probably pretty low, relatively low hanging fruit. These are things like time of use rates, allowing renewables to provide some of the reserves, and portfolio diversity. And storage really fits in kind of that third category where it's -- the model wants to add storage during some cases, not so much during other cases. And it really needs kind of a case-by-case investigation of is this type of resource cost effective at this particular time?

So I think with that I'll turn it over to Shucheng.

MR. BERBERICH: If I might, Mr. Chairman, comment on the model, I think implicit in the model is an economic tradeoff and -- well, it's called and economic tradeoff for now, between curtailment and storage. And really implicit to that is the cost of storage. So as storage -- what are your assumptions as far as storage coming down in cost in the model?

MR. OLSON: Yeah. We have -- slide ten sort of shows what we're assuming about the cost of storage overtime, and it's fairly aggressive.

And so the first thing is that it's --

MR. BERBERICH: Well --

MR. OLSON: -- there's not a lot of data now on grid-connected storage and what the cost of that is, even today.

MR. BERBERICH: Yeah. Well, what I was getting at, I saw this slide, but what I was -- I guess my question really is: Are we tracking on this line? Because the other tradeoff is as you go down this path towards pumped storage it's, you know, it's a long term big capital thing, and you have to make decisions around or at least make some anticipation of what the cost of storage will look like.

Because if distributed storage comes down significantly in costs it might be a better option, for instance, than bulk storage. And I think that's a policy issue people have to grapple with.

MR. OLSON: No, I think that's exactly right. And that's why I wanted to turn the focus to the services that the storage can provide. We'll need these long-duration services, but there are some cases where batteries -- even lithium ion batteries can provide those services more cost effectively if the cost trajectory looks like something like we see on the chart here today. Again, those -- those costs even today are very uncertain. Those trajectories were even more uncertain, so it's probably really too soon to know how this ultimately plays out.

PRESIDENT PICKER: I'd like to go to your slide 12 because actually I think this is the -- one of the more useful parts of the presentation. I think that this actually points to some of the other opportunities to address a lot of extra cheap electricity.

And so how do you contrast costs in terms of optimizing the -- the portfolio in terms of these other tactics? Is -- it seems like we -- you have focused a lot on bulk storage and storage. I'm just trying to get a picture of how these other resources actually fit within a range of -- of opportunities related to integration and extra energy.

MR. OLSON: So some of these solutions, we have reasonable estimates of the costs. You know, the portfolio diversity, for example, we have a good sense of what geothermal costs and more wind costs, either in-state or out-of-state relative to in-state solar.

We know that providing sub-hourly dispatch is relatively costless from a -- from a technical perspective. It requires a lot of transformation of the way that we think about how the -- how the markets work.

Flexible loads is another one where we think there’s a lot of potential there, but we don’t have a lot of good information about just how big that potential is, which specific end uses, how much it costs the consumer to want to do those things.

So what we’ve tried to do so far is, you know, optimize from among the solutions that we -- where we have reasonable costs for and then test kind of in-and-out cases for all of the other ones where we know there’s potential but we don’t have good cost information.

PRESIDENT PICKER: And so what doesn’t the resolve model include? And I’m just going to do some scattershot questions. Did you do vehicle for grid? Were there any assumptions in any tools that you used for evaluating that?

MR. OLSON: Yeah. No. That’s an area where, you know, we know there’s potential. You know, we don’t -- we know the potential is probably limited by people’s need to get from point A to point B. So we ran some cases where we assumed that there was some of that available and we found that if it is it’s very valuable. But again, we don’t really know what it costs to, you know, get consumers to perform that service for the grid. If it costs very little then it’s -- it rises, you know, very much to the top of this list. And that’s why we kind of have it at the top of that third box where we think we need to investigate that more before we know just how big that -- how much we can count on that solution.

PRESIDENT PICKER: And so characterize a little bit for me the flexible loads and advanced demand response category in your model.

MR. OLSON: Yeah. So this would include the vehicles. It might also include building loads. For example, you might do precooling or preheating. You might do like the Ice Bear technology, you know, other loads that -- there are residential loads we know that you can move around. The technology there is more challenging. And the outreach to, you know, millions of customers is more challenging. There’s just a whole broad variety of things you could do there.

PRESIDENT PICKER: So this is -- in some respects the challenge may be more centralized procurement and centralized decision making which -- which is clearly more accountable and more visible versus decentralized decision making and decentralized procurement?

MR. OLSON: Well, it seems to me there are some resources which lend themselves more to centralized procurement, the large-scale ones. There are others which you might -- which you can't really get that way. There are other ways that you want to try to -- to try to address those. And I don't think that you want to take one off the table. I think you want to pursue both.

PRESIDENT PICKER: Okay. I'm -- but I'm just trying to figure out how to deal with them in terms of the model and pursuing optimal opportunities.

MR. OLSON: Yeah. I mean, again, the model can only really optimize about what it knows about since there's -- there's a big data gap, particularly on the small-scale, you know, ability to do this -- this flexible load shifting. So we don't really have those -- any kind of a supply curve in the -- in the models today. But there is an effort underway through Lawrence Berkeley National Lab to try to put some flesh on that supply curve and understand better just sort of what -- what resources are available.

PRESIDENT PICKER: Essentially then the analysis really does assume business as usual and it doesn't really have the -- it doesn't -- it doesn't try to bend the technology curve to provide answers that we probably are going to be driving towards as we move towards 50 percent renewables.

MR. OLSON: Yeah. One of the reasons to do a study like this is to try to understand which curve to try to bend and where you want to put those research efforts and where you want to try to gather more of that data. So I think it is helping us in that regard. Things like time of use rates which we know are already going to happen, those we have imbedded into the base case and assumed that throughout all of our -- of our modeling. You know, the flexible loads where there's more uncertainty, you know, we didn't feel comfortable just assuming that that was going to be there in all cases at all times.

COMMISSIONER PETERMAN: I have a follow-up question to President Picker's comment about the capability of the resolve model. So for example, on electric vehicles, are you able to put in different assumptions or scenarios, a high -- a high penetration case, a low penetration case?

MR. OLSON: Yeah. That's one of the strengths of this -- this model in particular is that it's very quick to run. We can do lots and lots of scenarios with it. So we have done exactly that, we've run a case where you have lots of EVs. We've run a case where you had less. We've run a case where they're more flexible. We've run a case where they're less flexible, just to sort of see really -- you know, it doesn't tell you much about the EVs themselves because you kind of assume what they can do. What it tells you is how much the value is remaining for the other -- the other solutions if you assume you get this much from the EVs.

COMMISSIONER PETERMAN: It sounds like maybe there may be some interest in some follow up regarding what you have run. And perhaps there are some suggestions that the Commissioners have.

PRESIDENT PICKER: We have to look at these things in light of the -- the other requirements in SB 350, particularly the integrated resource portfolio as opposed to the simple metric we've been pursuing in counting renewables. And so as we move into this these kinds of constraint arguments around curtailment and storage sort of become confining for us as we have to go wrestle with all these other questions.

COMMISSIONER PETERMAN: I also wanted to make a follow-up comment and question related to costs again on slide ten. And I see how you have all the bulk storage costs getting to cost comparable with bulk -- pumped storage in 2030.

And I recently had some conversations with some

Japanese companies and the Japanese government in terms of their investments on some bulk storage projects. And the Japanese government has given the direction to the companies to shoot as your prize target, you know, bulk storage, a 12-hour product. But I didn't get specifics exactly on how we would get there.

And so I welcome your thoughts or your feedback about whether it's, you know, technology improvements or if these are driven by some kind of economies of scale or some exceptions -- assumptions around global deployment.

MR. OLSON: Yeah. I think it's really a combination of all those things.

UNIDENTIFIED MALE: (Via WebEx.) Yeah. Can folks hear me? Okay. Great.

CHAIR WEISENMILLER: No, actually, this -- we're not taking questions.

UNIDENTIFIED MALE: So it's a huge advantage --

CHAIR WEISENMILLER: We're not taking questions --

UNIDENTIFIED MALE: -- for us too.

CHAIR WEISENMILLER: -- from the audience. Please cut it off.

UNIDENTIFIED MALE: Please talk to the customer first and ask them what their requirements, and then (inaudible). So it's a huge success --

CHAIR WEISENMILLER: As I said at the beginning, no questions or comments --

UNIDENTIFIED MALE: -- and that's great.

CHAIR WEISENMILLER: -- from the audience.

UNIDENTIFIED MALE: I think the --

CHAIR WEISENMILLER: So we're moving on.

UNIDENTIFIED MALE: I think the challenge (inaudible).

CHAIR WEISENMILLER: Please, you're cut off. Shut up. Thank you.

UNIDENTIFIED MALE: It --

CHAIR WEISENMILLER: You're shut up. Shut up. We're not taking comments at this stage. The end of the day. Put in a card.

COMMISSIONER PETERMAN: Thank you.

CHAIR WEISENMILLER: Okay.

COMMISSIONER PETERMAN: Please continue.

MR. OLSON: Well, I just was going to note that what we've seen on the solar side is that there's a big scale-up in manufacturing. It has just by itself resulted in big cost reductions. That has also resulted in the kind of research that is needed to drive, you know, to improve the technology to make the panels more efficient, make them more durable to reduce the racking (phonetic) and the other balance -- balance of system costs. I think we'd expect the same kind of thing to happen with batteries, that it's really the scale-up that drives both the manufacturing and economies of scale, but then also the research that's needed and the -- sort of the technology perfection that's needed.

COMMISSIONER PETERMAN: Okay. Then I won't pursue this point any more at length.

But my understanding in terms of the cost projections on the lithium ion batteries, that that's being driven largely by the transportation electrification market and that's where the majority of the batteries are going. It's not clear to me -- I just don't know the underlying technology on the flow battery, for example, about whether there is that other type of market that's driving those costs to climb. So I'd be interested if anyone has any more information, some technology roadmaps for some of those other bulk storage technologies, I'd love to see them, so please send them along. Thank you.

CHAIR WEISENMILLER: Well, we will certain have written comments, and that would be great for that -- those sort of submittals.

MR. OLSON: Okay.

CHAIR WEISENMILLER: Okay.

MR. ROTHLEDER: I just wanted to preview, before we go into Shucheng Lui's presentation, the work that Shucheng is doing is more traditional production simulation based on the assumptions that were used in the long-term procurement proceeding. That doesn’t mean -- and they are focused on the question: What does the storage do to improving over-generation, and then the production costs? That’s not to say that we are ignoring other solutions. And in fact, we believe that there are several solutions that need to take place to -- and change from existing practices in terms of procurement, as well as using other types of resources load for solutions.

But the work that we’re doing here now is focused because it was intended to focus on the bulk storage question. So I just wanted to make sure you’re oriented on that as we get into this work.

And the contrast as to the resolve model, the resolve model is kind of assessing what the options are from an investment strategy to achieve an objective. This is more focused on from the production costs what does it do to mitigating the over-generation itself?

So with that, I’ll turn it over to Shucheng.

MR. LUI: All right. Thank you. So let me start with some background information. In 2014 the ISO conducted a study for the CPUC Long-Term Procurement Plan proceeding. And the study follows the CPUC standard planning assumptions in the scenario. In the study the ISO studied the following four scenarios in the one sensitivity case. The results of the studies were filed in the CPUC LTPP proceeding last year.

In the study, specifically in the 40 percent RPS in the 2024 scenario, we identified a large quantity of renewable generation was curtailed. So this scatter chart basically tells you, you know, the frequency, the volume, and when it happens. So for the whole year there was -- there was 822 hours of curtailment. And the total, about 2,825 gigawatt hours were curtailed. And the largest single our of curtailment is 13,402 megawatts. Based on that the ISO started exploring the solutions, just like Mark mentioned, and also looking at the whole array of solutions, and storage is one of them.

So that is the purpose of this study. As Mark mentioned, we're -- you know, we try to isolate and take a closer look at a large block of storage -- energy storage resource, how it can help to reduce the curtailment, you know, as Mr. Picker mentioned -- Chairman Picker [sic] mentioned that, how we can make use of the cheap energy that we were not able to absorb.

And also as a result we can reduce, you know, emission and reduce the cost. And at the same time we can reduce the renewable over-build in order to achieve the 40 RPS target.

The analysis, you know, on the economic side, we tested. And you know, this is the phase, we are using the information we can gather. And this is an area we need additional input from all the parties to help us to get a little more accurate of the cost figures of the renewable and the storage, so that. And as Mark mentioned, we are in the process of doing another study based on the 50 percent RPS so that we can refine the process and get better results.

For the approach this study is based on the 2014 LTPP 40 Percent RPS in the 2024 scenario. And we also keep the same assumption that the renewable curtailment is on there so that -- but it has the price of negative $300 per mega-hour. When neighbors (phonetic) market current price reached negative $300 per mega-hour there, it means that there is renewable energy curtailed.

This analysis is conducted based on two baselines of renewable buildout, and combined with the pumped storage -- bulk storage resource in there. Basically, we look at this, what if we do just as we did in the 2014 LTPP study, which means that there’s no renewable overbuild. So if we curtail renewables we don’t meet the 40 percent RPS target. And another (inaudible) is we build additional renewable resource on top of a curtailment and make sure that we actually achieve the 40 percent RPS target.

With the overbuild we did two cases. One we did all the additional overbuild with the solar resource, and the other case is always the wind. This is -- we try to test, you know, test the benefits of diversified portfolios. The 40 percent RPS in 2024 scenario, the solar takes about a 53 percent capacity of the whole RPS portfolio. So if we overbuild solar on top of that the solar becomes more dominate. But if we build wind on top of that we increase the diversity of the RPS portfolio so we can see how it comes out and what -- what are the benefits of the different portfolios.

This is an illustration of the cases we constructed. We start with Case A which is 2014 LTPP 40 percent RPS scenario. We started with there and we build Case C which is a plus-solar overbuild. So we basically scale up all the new solar resource generation profiles to solar interactive process until we meet the 40 percent RPS energy requirement. And the Case C is -- Case D is A with wind overbuild. It's the same way, but we look at it specifically just scale up the wind resource, and everything else keeps the same.

And from A to B is no overbuild, but we put in a bulk storage resource in there. And then we say what if we don't meet the 40 percent, how the storage is going to help? And from B we add overbuild with the storage, you know, how much overbuild we need with solar to meet the 40 percent RPS target, and with the wind, to meet the 40 percent target.

So the takeaway from this study, basically we tried to quantify how much the production costs, the curtailment, and the Co2 emission can be reduced with the overbuild and with the pump -- with the bulk storage. And we also tried to quantify the cost and the quantity of the overbuild needed. So that means if we put in a bulk storage resource into the system, then how much overbuild can be reduced? That's the benefit, you know, the -- the bulk storage it will bring to the system. We also look at the bulk storage resource itself, look at how much revenue it can make from the market itself, so can it live by itself?

And we want to make sure that people understand that in this study we don't try to quantify the transmission impact, even though in the cost calculation the cost of the renewable and the bulk storage resource all have a component of the transmission upgrade. But in this study we don't try to identify whether it's going to cause additional transmission congestion or whatsoever, because this -- this model is focused on the resource and not on the transmission.

Next slide.

So this slide shows assumptions of pumped storage. We use a large pumped storage, you know, as an example of a bulk storage resource. And this, you see the assumptions that we highlighted here. This is a 500 megawatt generation capacity, 600 megawatt pumping capacity, variable speed pumped storage. And it's modeled as two identical resources. It has a very fast ramping rate. You can ramp up 250 megawatts in a minute, which is pretty fast. But based on our search, you know, research, this is not as fast because the information we gathered, the variable speed pump can ramp ten megawatt per second. So this is -- and the benefit of a variable speed pump is that in the pumping mode it can provide (inaudible). Besides, it can do the same thing in generation mode.

Since this is purely based on the ISO research and the information and the -- it's kind of represented kind of general in the average of the different information that we can find from the provided available information. But we definitely welcome input from the parties here, and there are a lot of experts.

CHAIR WEISENMILLER: Yes, sir, one question. Obviously California has a very rich system of hydro facilities, including a couple of older pumped storage projects. If you were assuming not variable speed but, you know, sort of the types of technology people have put in historically, what would be the ramp rate in that case?

MR. LUI: For example, on the PG&E Helms, I don't remember exactly sort of like how much -- what's the ramp rate there? Is it like a 20/50?

CHAIR WEISENMILLER: Okay. Yeah. And I mean, obviously because, you know, Helms and Castaic, at least the traditional pumped storage is something we want to get into later. But in addition, we have a lot of pondage hydro around the state which again has some operational flexibility. Now with the Berkeley licensing, much of the hydro system is shifting more to under (phonetic) the river from pondage. I think PG&E went from, in the '80s, two-thirds pondage down to about two-thirds under the river. So again, there's less flexibility there, but there's still some.

MR. ROTHLEDER: I think your question is well taken in that as we -- as we explore this question of bulk storage I think we have to ask the question and evaluate, are we making the full utilization of our existing resources or is there anything we could do to them to get more out of them in terms of the capabilities or utilize them in a better way? And it's -- I think that should be part of the exploration going forward.

MR. LUI: Okay. Well, one thing I want to mention here is even with a variable speed pump and the translation from the pumping to generation or from generation to pumping, there is a small gap. So there is like a few minutes gap. It's not like some battery storage as they specify that. You can (inaudible) from charge into discharge in (inaudible). So that actually affects the storage capability to provide the reserve. So if they can (inaudible) seamlessly and so they can provide reserve ancillary service in the transition process, if there's a gap it could affect their capability.

PRESIDENT PICKER: And I'm -- this is probably in the weeds engineering question. Is the gap in full stop to start or is if you're already providing some resources with the variable speed pump does it -- do you get more quick transition because you're already engaged? I'm just --

MR. ROTHLEDER: Well, the variable speed drive that ability to dispatch either in pump mode or generation mode, whereas the -- like for example, Helms, when you're in pump mode it's either on or off.

PRESIDENT PICKER: Right.

MR. ROTHLEDER: So you're -- you don't get that discrete dispatch capability. And I think that enhances if you want to use it for regulation or if you want to use it for dispatch reserves while it's pumping, that is the added value of the variable speed drive.

But I think the other value is that transition when you're going from generation to pump or back and forth, that is a much smoother, quicker process. And if you've -- in times when you have to respond in ten minutes for NERC reliability purposes, things like that start to matter, or if you’re talking about frequency responsiveness, some of those things start to matter.

PRESIDENT PICKER: Yeah. I’m just trying to get at, you know, how long -- how long is the gap in transition for variable speed?

MR. LUI: Based on our research there’s like between five to ten minutes.

PRESIDENT PICKER: Okay.

MR. LUI: And the one other thing that’s not included in this table is we modeled this pumped storage with (inaudible) variable (inaudible) the maintenance cost which is part of the cost of trying to cover both operation, and also the evaporation. So that means is evaporating and you need to fill in additional water, there’s additional cost associated with that.

So this is the result. And this chart -- actually, no, it shows you quite -- quite a lot of -- a lot of information here.

First, Case A, of course, there’s nothing happened. And Case B for the 500 megawatt pumped storage there. Case C, there’s the new pumps. It’s pumped storage but a solar overbuild. And Case D is no pumped storage but the wind overbuild. And E is solar overbuild on top of pumped storage. And D is wind overbuild on top of pumped storage.

So you can see that the solar overbuild between C and D, you can see the solar overbuild requires a lot more than wind. This is because when we have a curtailment in the -- in the Case A and you build additional solar, it (inaudible) pretty much the same generation (inaudible). So that means for the hours that you have curtailment already and you add more only you -- you benefit from the hours that you don’t have curtailment yet and you add more to the cost of additional curtailment.

So wind is pretty much kind of spread out, especially high, even higher in the early morning and the late evening, but lower during the day. So I mean, you know, it accounts -- adds less additional curtailment to the midday hours. Therefore, you know, you get more energy out of the overbuild than each megawatt and then the solar. So in order to reach the same goal, solar requires a lot more.

Secondly, if you look between C and E, so that means, you know, how much the pumped storage is going to displace the solar overbuild, it’s not a one-to-one. 500 megawatt pumped storage reduced 349 megawatt solar overbuild. What does it mean is if you look at -- well, if you go back to the chart, for example, so where you have 500 megawatt pumped storage you can’t -- at a maximum it can absorb only the bottom portion of the renewable that get curtailed. So when you have a curtailment greater than 500 megawatt you cannot capture all of them, even though this pumped storage is a pretty long duration, it is 12 hours full generation capability. But at any single hour it can capture only up to a 500 megawatt.

So this one comes with a question about, you know, between duration and the capacity. So duration matters because our curtailment lasts about eight to nine hours. So that means if you can continuously pump during those hours you cover all the hours. At the same time we have a curtailment larger than 500 megawatt. The pumped storage is not able to capture all of them there.

That's why you see the replacement is not, you know, one-to-one. But if you increase -- increase the size of pumped storage, then the cost goes up and then your utilization probably don't, you know, get as high as the first part because the frequency of a curtailment, like a higher volume is lower than that at the bottom part.

So this is about the curtailment how much curtailment can be reduced. So this is also a lot of information. Let's start with, you know, looking at -- just at the blue bars between A and the C. So A, there is no overbuild and C is overbuild. So when you build additional solar you contribute a lot -- you know, a big portion of an overbuild to the curtailment hours. So that means that you need a lot more -- it costs a lot. You know, curtailment is higher than with the overbuild. But with the wind, and so that’s between A and D, you can see the incremental curtailment is less because you a better utilization when the wind contributes to the hours that you don’t have a curtailment.

Then between C and D, you can see this is solar, between the solar and the wind. The solar is still the same question, as I mentioned. And solar contributes more curtailment and the wind contributes less. And then (inaudible), so that means that without curtailment how much of the -- the curtailment that can be reduced or can be reused. So that means the cheap clean energy that was curtailed now can be used by, you know, the pumped storage to absorb this energy during the curtailment hours and the using it later time. So obviously, you know, you can see that it’s quite significant.

But the most significant contribution for the pumped storage is with wind overbuild -- with solar overbuild, I’m sorry. So pumped storage works best is that when you have a certain hour, a concentrated hour with large volume of overbuild, so the price goes really low. And then you have other hours where you need a lot more additional energy, so then you can regenerate from the pumped storage. So you can move from the highly curtailed hours into the highly, you know, required hours. And that’s where the pumped storage is the most value, it shows in the -- in the curtailment. So on the other hand, the solar overbuild does cause additional curtailment, and it also requires overbuild of megawatts.

So this is emission. And the emission is also kind of interesting. First, without overbuild, and of course, without overbuild you curtail that much -- that much energy that you have to make up because your demand is fixed, is that much total (inaudible) there, you know, in order to serve the demand after you curtail that much renewable you have to use, you know, generation of other -- other types of resources to fill in the gap. And other types of resources cost certain emission. So without overbuild the emission is higher.

But with a solar overbuild, then you can between A and C, the emission was reduced quite a bit. And that -- what that means is that when you overbuild you -- you make sure that you have that much renewable energy getting to there and that you don’t need the other type of generation to fill in the gap. So you displace the other portion of polluting energy with clean energy at the cost of overbuild.

The interesting thing is between C and D. So with the wind and the solar, emissions with wind is lower than with the solar overbuild. So this one is the first, you know, very straight, in tune, kind of intuitive answer is solar overbuild makes the ramp in the morning and the evening steeper. So that means that you need another type of resource to help you ramp. Whereas with wind, wind, it does not increase your ramp that much because wind comes in as a pretty, you know, relative flat. So that means it does not necessarily need additional, say like a peaker type of a resource to come on cycle to help, you know, during the ramping time. Therefore, the additional emission reduction is achieved.

And also with the pumped storage, you can see the reduction with pumped storage, of course, between the solar overbuild and the wind build -- wind overbuild -- solar overbuild has a slightly higher reduction by the pumped storage because it's, like I said earlier, that the pumped storage works better with the solar -- with the higher solar penetration than -- than with the wind.

Of course, the production costs, this is the total production costs of the whole (inaudible). There is a significant reduction of that. But this -- this one comes down to the question that the pumped storage reduces the production cost of the system. It's a contribution to the society or to the system. And how it should be rewarded, that's, you know, that's the question based on how the, you know, pumped storage resources would be recognized as either as an independent power producer or as under certain recovery mechanism. But you can see that wind is still a better option of -- between the solar and the wind overbuild.

So this is the cost we calculated. We -- basically, this is the -- we call or label as the annual revenue requirement, or some people call it the (inaudible) fixed cost. We did the calculation based on the cost information that -- a study (inaudible) did for the WCC in March 2014. And we recognize that the numbers are changing constantly, especially the renewable, they're changing constantly. So we would like to, you know, gather information from the -- all the parties so that we can refine this calculation.

But as you can see here, this solar overbuild, the overbuild obviously is more expensive than wind, and that's the benefit of the more diversified portfolio. And also with pumped storage on top of the overbuild, the cost does not -- you know, if you just look at the revenue requirement, the cost of pumped storage, it does not reduce as much as is the cost now for the solar or the wind overbuild, which means that some of solar overbuild costs -- overbuild and the pumped storage cost is higher than this, you know, pure solar overbuild without the pumped storage.

And lastly, we look at what if the pumped storage is going to stand alone, so that means to realize its revenue from the market. So the revenue we have calculated here includes the revenue from its energy generation, the ancillary service and load following it would provide, and minus the cost of operation which is -- the variable of operating cost is $3.00 per megawatt hour, as well as the cost of energy to consumers to pump.

And so these numbers are, you know, on the -- as I said, the revenue requirement, the green bar is -- probably needs to be refined. Based on the numbers it seems like the solar overbuild it could be self-sufficient. Of course, this depends on all the assumptions. One of the major assumptions here is the renewable curtailment price. We model as a renewable price at the negative $300 per megawatt hour which means that when we have a curtailment and the pumped storage charges each megawatt hour get paid for $300. And that adds -- you know, that's a significant portion of its revenue. If this assumption changes, for example, currently the ISO has been for 150 -- negative $150 per megawatt hour, if that's going to be the case in 2024 then the revenue will be -- cut off a big chunk of it.

And there's one other component that was not included in this chart is renewable overbuild seven. So this is -- this is on the -- on the slide -- chart 12. So the overbuild, the pumped storage is put in there. It saves $128 million per year for the solar overbuild. So it's a contribution that -- by -- made by the pumped storage. With the pumped storage you'd be rewarded by that or not if you add 128 on top of the purple bar in the middle. That, even though you cut, you know, the curtailment price down, that could still be a big chunk of it. But this really depends on the policy decision, how the pumped storage, you can be awarded for its contribution to the system.

MR. ROTHLEDER: Let me just close a little bit out here. I think what you can take away from what you've seen today so far is that it's clear that the storage proposition does have benefits to the system. It does reduce production costs. It helps mitigate curtailment. It uses that curtailment for the good and reduces the potential for having to back up some of the build with additional build to make the same renewable portfolio target.

But I think the other thing that you -- you get out of this is that the proposition of the storage and the value of the storage is very sensitive to several things. The sensitivity is what is your portfolio mix itself? The more diverse the portfolio the different -- there's a different value proposition for the storage. So the -- we have to look in the context of what are the portfolio mixes going to be? And then as we look forward we'll be looking at the 50 percent and the portfolio mix at that point.

I'm going to go up one. Okay.

We do -- we do see that bulk storage does provide additional benefits in terms of reduced curtailment, Co2 reduction. It does help reduce that midday capability. It provides ramping capability. As the sun goes down it can provide that ramping and dispatch capability when you need it. It allows you to basically move energy from the evening to the morning and back and forth. And it again reduces the Co2 emissions.

In terms of our next steps, we're going to continue this work effort and we're going to start moving on to the 50 percent renewable cases. And that -- the question there is, obviously, what's the portfolio going to be? We'll be working with the CPUC and others in using some portfolios to start with based on at least the RPS calculator.

The other thing we will be doing is we'll be using the information about the loads from the IEPR. The -- in that discussion we have to consider whether the loads are -- how much behind-the-meter solar PV there is, and also how much of those loads are going to potentially be affected by time of use rates in the longer term. But we'll start with at least the 2014 IEPR forecast for at least the work going on right now.

In terms of the other elements, we did not look at the value of the frequency response. We know that the bulk storage has the capability of meeting frequency response. And we think that we can evaluate that as we refine some of the requirements that we had in the LTPP case about the minimum amount of generation in the local areas. And so we will be refining that.

As well, we will be refining our assumptions about how renewables themselves can actually help integrate renewables. And what I mean by that is using the renewables to be dispatchable for load following down actually helps reduce the curtailment risk of other resources, rather than using potentially conventional resources for that load following down capability. So we'll incorporate that into the work going forward.

And the other -- the last thing is we will also look at the sensitivity with regards to the export capability and the prospect of being able to do more regional coordination that would lead to optimized dispatch across the region, how does that then interplay with the value of the solution using bulk storage.

So the last thing is, is that in order to move forward on the study work we will need to refine the economic analysis. And we will need to have updated information about what the bulk storage costs are now, what the overall storage cost projections are going forward. Is there technology improvements that will reduce those costs of both bulk storage, battery storage and different technologies? We want to look at that. And the reason we want to look at that, because as you can see from this, this is a complicated question. When do you start making decisions about potentially committing to some bulk storage in the timeframe, considering the lead time of the resources, considering the fact that some of the other technology costs may be coming down? Those other technologies may have shorter lead times. And so when do you start getting to that point where you have a least regrets decision and how much do you want to commit to at that point, in light of those other changing factors.

So it's -- it's -- it is a complicated question but I think at the very least you're seeing today that there is -- there is definitely benefits. When those benefits are great enough to commit to in light of the uncertainty about those other things, that's the question that we need to try to get -- get an answer to.

This is just information in terms of the numbers. I'm not going to go through this in detail.

I just want to say thank you very much for the opportunity for discussing this important subject.

CHAIR WEISENMILLER: Great. Thank you.

Steve?

MR. BERBERICH: Well, I have a couple questions.

First I guess is probably a relatively easy one.

Are there any NERC issues associated with using storage for any of the ancillary services, suites, like a regulation?

MR. ROTHLEDER: As long as it is frequency responsive and it responds to ACG signals there really shouldn’t be any problem in using it for those services.

The second question is going back to slide 13. What I get from this is that effectively the revenue that you can get out of the market will roughly offset the operational costs. However, it doesn’t look like it took into capital -- account, capital costs. Is that fair?

MR. ROTHLEDER: Shecheng?

MR. LUI: Actually, yeah, this purple bar is purely from the markets. It does not consider any capital costs. But the green bar is the capital cost requirements.

MR. ROTHLEDER: I want to be --

MR. BERBERICH: So the green bar does include the, we’ll call it the -- the amortization of the capital costs as well?

MR. ROTHLEDER: Yes, of the -- of the storage itself.

But I also want to make a point here because Shecheng pointed out, this is based on the existing or the market expectation design that the bid floor will go down towards negative $300. If you don't go down to a lower bid floor this -- that revenue potentially will not be at this level. So it's very sensitive to your market design, as well, in terms of the -- the willingness to pay for reducing output. So the negative bid floor and the level of that is important to this question.

MR. BERBERICH: Thank you.

CHAIR WEISENMILLER: Yeah. So I had a couple of questions/observations.

First, in the '80s, you know, in terms of the value of Helms, one of the things that popped up pretty clearly was California -- you're running this with basically expected hydro. And Helms would run a certain level at expected or average hydro, it's never quite average. In a dry year it obviously did not much. And in a wet year it did a lot.

Now so in terms of presumably if you look through these sensitivity cases, moving off of expected cases to the range of hydro, you'll find that depending upon the range of the wet year you're going to find much more value. And so, you know, what that does to the economics in average, but it's certainly, when you look at some of the operational implications you have to plan across the range there.

The other part of it was and one of the issues that came up when we had the El Nino in '82, PG&E decided the interpretation of the Unical steam contracts was hydro spill included not just California but anywhere in the West. And they then proceeded into a ten-year litigation on that issue since Unical thought when the contracts were negotiated it was hydro spill into PG&E's system.

So as we go into, you know, the operational flexibility for the renewables, you know, some might consider that curtailment. Some might consider that issues with existing contracts. Obviously, with the new contracts it's pretty much an open slate on sort of what you're building and for operational flexibility. But we do have to be careful or at least think through what you need to do to get operational flexibility on the existing projects, you know? And I mean, there's obviously some curtailment terms in the existing, you know, for a couple hundred hours. But I'm sure the owners of the contracts will probably just be happy if they get paid more, while I assume the ratepayer advocates will look more at what's in the contracts already and how you're trying to shape that. But obviously contract renegotiations take a hell of a long time.

COMMISSIONER PETERMAN: Thank you for the presentation. That was very interesting.

I understand one of the potential benefits to bulk storage to be transmission deferral. And we're having an ongoing conversation through RETI 2.0 about potential transmission needs for 50 percent renewables.

So given that, have you done any analysis of the potential transmission deferral from these projects or what would that depend on, what would that value depend on?

MR. ROTHLEDER: Yeah. As Shucheng indicated earlier, this does not -- this did not look at the transmission deferral question. This was more the system flexibility, balancing capability and other services. I think that question that you're -- you just put forth, I think that will be taken up in conjunction with our transmission planning efforts. And the question there is obviously does -- is very dependent on the location of the resource, can you find that right location and actually can do something in terms of mitigating a transmission constraint. But that's not what we were able to do in this effort.

COMMISSIONER PETERMAN: I'll also note that in addition to the location of the storage facility depends on the location of that overbuild of wind, and solar as well. Because it seemed that that resource mix was a key driver in terms of some of the costs, and so there's that integration there about what the transmission needs would be for those resources --

MR. ROTHLEDER: Yeah.

COMMISSIONER PETERMAN: -- or not.

MR. ROTHLEDER: And to that point, this -- at least in this study we put the resource in Southern California. And we did observe, even this year because of constraints on Path 15, we had a larger amount of curtailment because of those constraints south to north. That was because of maintenance work this year. But it's not implausible that if you have a large concentration of solar in Southern California in certain loading conditions you could get hit by that limit. And then location of the over (phonetic) storage resource really may matter as well.

PRESIDENT PICKER: I'm just going to try to reflect a little bit on the challenges that we face as we tool up for implementing SB 350. And I just want to again remind myself and folks some of the requirements.

So the ARB is going to give us a number that's constantly being reduced over time. It calls for them to establish the GHG emission reduction targets. And then it does reflect the electricity sector's percentage in achieving the economy-wide GHG emission targets, and then it ratchets down over time to reach that target.

So we're taxed with a couple of things, including developing a broad integrated resource portfolio procurement process that really focuses on meeting that goal while achieving other system requirements such as reliability and affordability.

We do have the ongoing requirement to count renewables. But it also kind of takes us back to that since it requires consideration of those GHG limits and a consideration of the capacity and system reliability issues, as well as least cost and best fit.

So one of the -- the real useful observations that -- that we get here is that you make the argument that bulk storage brings a benefit. And I can't contrast that easily to other technologies and other opportunities. You know, it just says that it reduces curtailment, and the thing that leaps out is Co2 emissions. It also probably has some impact in terms of choices in terms of which technologies you match it with.

MR. ROTHLEDER: Right.

PRESIDENT PICKER: But again, if we're -- if we're -- we're putting it in -- in a world where we're really counting the Co2 emissions, it seems to me that that's really what we want to be focusing on.

I will say that we have some other challenges in that we're actually now being tasked to use clean electricity, that over-generation to actually meet needs for reducing greenhouse gas emission in other industries. So the over-generation that we talk about may actually sort of disappear as we see more demand in other market sectors like buildings where we use gas and transportation where we use petroleum.

So I'm -- but I do think that this -- this question of how it fits in as a specific tool in this new integrated resource portfolio and how it meets these least cost/best fit requirements is really valuable. So I'm trying to figure out, as you take the next steps in terms of your study, how do we actually quantify some of these -- these benefits in relationship to other technologies so that we can really get at those criteria for least cost/best fit, and especially in terms of greenhouse gas emissions, but also the system reliability and the overall costs. So those are the things that I'm struggling with.

MR. ROTHLEDER: And that's a fair point and it's -- I think you have to start doing some of those comparative analyses of increments. If you add an increment of a certain type of demand response or other solution, what does it get you? And then you, I think along the lines of what Arne had, start doing that comparison of what you get and then try to really optimize a solution to a certain objective. Now it may lead to a different solution if your objective is to minimize cost, capital cost. It may lead you to a different direction if the objective is minimizing or getting to a greenhouse gas target level. So they may guide you to slightly different pathways or solutions.

But I agree with you that you have to start looking at these things, not in isolation but in combination with a variety of the solutions. And then what is the best ensemble of solutions that you can come to? And that's -- that's really kind of the optimization question is how do you optimize and time that and sequence it just right to achieve your best objective.

PRESIDENT PICKER: It seems like both lines of research, the resolve model and the work that -- that you were doing at the ISO, have some of the elements that we need to begin to focus on already incorporated in them a lot as to the way that you frame them.

MR. ROTHLEDER: Yeah.

PRESIDENT PICKER: So, you know, I'm trying to train myself to count greenhouse gas reductions, not renewables. And so as we do that how does that reframe the way that we state these challenges and what kinds -- what we will emphasize? How would we shift some of the research?

So those are -- those are questions we may not get to here, but I'm wrestling with them.

MR. ROTHLEDER: Yeah.

COMMISSIONER PETERMAN: And I would just say it seems to me, even before optimization, that with the models one can just run. What does that need to be fulfilled all with bulk storage, to be fulfilled with all deficiency demand response, to be fulfilled at all with batteries, just to get the baseline of relative cost in that way?

MR. ROTHLEDER: Right.

COMMISSIONER PETERMAN: And then I think that will give us some sense of relative costs. But then, of course, some resources can be advantaged from some optimization with some others.

MR. ROTHLEDER: Yeah. And I think the optimization is when you start making decisions, and the right decisions relative to those costs. I mean, we've got -- these results do kind of give you directionally what does it do, but it doesn't answer the question: When do you do it and when is the -- when -- what do you do in combination of other things?

CHAIR WEISENMILLER: Thanks. Let's move on to the next panel so we can --

MR. BARKER: Okay. So as we move on -- thanks everybody.

As we move on to the next panel, if Mike Jones and Kelly Rogers can come up to the front? We also have John Dennis from LADWP who will be presenting remotely.

I probably should have mentioned at the beginning of the workshop the house rules. How we have it set up today is that the questions of the panelists will -- will only come from the dais. And we do have opportunity for public comment towards the end of the workshop. We have it scheduled for about 2:15, just to give you an idea of time. So that's both for folks in the room and everyone on WebEx. We also have opportunity for written comments which are -- will be due December 18th at 4:00 p.m. And the docket is 15-MISC-05.

So with that we're going to start with the presentation from Mike Jones of PG&E. And then we'll move on to John Dennis at LADWP and Kelly Rogers from San Diego Water Authority.

Let me pull up your presentation, Mark. Do you recall what your -- Mark, what your -- the title was called?

MR. JONES: (Off mike.) (Inaudible.)

MR. BARKER: Is it this one? There. Sorry about that. Thanks. Go for it.

MR. JONES: (Off mike.) Thanks you. (Inaudible.)

THE REPORTER: Mike please.

MR. JONES: Thank you very much. Thank you for having us here today. It's a great opportunity to really share, compare notes. And we appreciate PG&E to be part of the conversation.

For the record my name is Michael L. Jones but I go by Mike. Okay.

It's important PG&E takes really a technology-neutral approach when we think about storage and meeting the energy needs of our customers. Our focus is on delivering safe, reliable, affordable and clean service. And that may show itself in a variety of different technological solutions here. And we think that there's appropriate storage technologies that can be applied in a variety of different ways. And we really think we ought to be looking for the right tool for the right job.

And so pumped storage is part of our existing portfolio and may be part of our portfolio in the future. And I'm here to talk about experiences and benefits of pumped storage, particularly for Helms project, and also perhaps barriers to current and future development.

So here's a little background on Helms. I've got a little cartoon there for you to see. It's an underground, underwater pumped storage facility. It's been delivering energy storage functionality for over 31 years now. It does so with both long-duration and short-duration services. It's got two substantial reservoirs sized with it, so it can deliver in continuous pumping mode or continuous generating mode for days at a time if necessary. It's got 1,200 megawatts of generating capability and 930 megawatts of pumping capability.

So key things about Helms is that it is a proven technology. It's been there for 31 years providing these resources or this functionality. It provides energy, capacity, ancillary services, including regulation, spinning, non-spinning reserves, and other services that it performs, including voltage support, reactive power to help maintain grid stability. An example of its functional use, 75 days so far this year Helms has been called on by the CAISO to provide quick solutions in either pump or generating mode to better supply support for voltage for the system and general system reliability needs.

Helms is 3 million pounds of rotating equipment that provides inertia that helps provide stable grid operation. And it’s also very fast acting.

There was a question earlier about what its ramping rates for the individual units are; 80 megawatts a minute. There’s questions about could you improve upon that, and we could dive into that if -- if you wish. We also have heard about reducing over-generation this morning, and Helms has the capability of doing that. And examples of that over the past three years, Helms pumps have been used 13 of the last 19 over-generation events ranging from 300 to 600 megawatts as whatever was required at the time. So that’s 600 -- 300 to 600 megawatts of consumption off the grid to help with that over-gen scenario.

So as we think Helms’ history and its evolving use over the changing energy landscape, there’s really three different kinds of stages in history of Helms.

The conventional wisdom when Helms was first being developed and built was to be taking excess supply off the grid at nighttime by pumping water uphill, and then providing that energy back to the grid during peak energy time in the daytime.

Then during the energy crisis the facility was called upon repeatedly at all kinds of times of the day to generate and to pump at a variety of different times that you really wouldn't recognize by the original design model of what the plans for the facility was.

And more recently the facility continues to operate in times and ways that we didn't really quite think of 31 years ago.

And let me share with you an example of a graph from an actual day in July this year. And you can see that we had a pump cycle between hour four and hour five where we were pumping this particular unit, a little over 300 megawatts of consumption off the grid. And then our next pumping cycle was at 10 o'clock in the morning until almost 2:00 in the afternoon, midday pumping. And then you can see the gen mode as we -- from 1700 hours on we were in the generation mode and providing a variety of different resources there. Whatever the grid needed at that point in time, the asset was dispatched accordingly. Okay.

So we've seen this really in the last three years change pretty dramatically, midday pumping in July and August in particular. These were things that nobody really kind of thought about in the original days that we'd even be thinking about doing at this point in time.

So let me take you back to 2013. We had no pumping in July in 2013, and it was pretty minimal in August. And then as we step up to 2014 we see a little bit in July. And we see one-third of the time in August we were in pumping mode at this point in time, midday pumping. And then as we look at 2015 about 30 percent of the days in each of those months we've been in midday pumping mode.

So as we think about barriers, we've heard some conversations about them. I think Mark Rothleder described this first one, you know, very well, you know, we all recognize this is a large capital outlay if you're talking about deploying a new pumped storage facility, a long development lead time. This is kind of hard stuff to do, and we all recognize that. I think everybody here does.

And I think there's some things on the development cycle that makes it long that's actually kind of a good thing. Because the licensing process for developing such a facility, it's very, you know, transparent and methodical, and you work with a broad group of stakeholders. And I think at the end of the day you end up getting better answers because you've devoted the time and development of that. So, you know, development timeframe is important, it's an important attribute and we've just got to recognize that that's part of the overall equation there; right?

The large capital outlay, everybody knows that that's, you know, that's a hard thing to get a good decision on, for exactly the reasons Mark was just describing. So things that can help in this area is to have a known dependable approval path that's critical to secure financing and funding necessary to develop and build and operate such a project over a long-term time window, as we were discussing; right?

Additionally, the recognition of the value of services. You know, voltage support and flexible ramping functionality are examples of capabilities that currently really aren't recognized in the market. This facility has enormous capabilities in those areas. And we've seen the CAISO depends upon them to be performed. And part of this equation of looking at the benefits and trying to figure that out is how do you quantify that? How do you value that? How do you put that in the equation of the cost versus benefits conversation?

And so we look forward to continuing to work with the CAISO to help value this information or value this capability and make it more transparent and more public so it's more visible as to what that value really is. Okay.

The third bullet is really talking about equitable cost allocation. There's a lot of people who benefit from the functionality of these kinds of resources, and it shows up in a variety of ways. And any storage solution just really needs to go ahead and allocate these costs to everybody who benefits from this kind of a resource.

Ensuring asset utilization. This is an important piece. Over time, you know, functionality of Helms, we've improved that and have been able to demonstrate a lot of extra things that we didn't think we could do originally when we were first doing that. And the CAISO has helped in recently approving a variety of infrastructure projects in the Greater Fresno area to improve reliability for the Greater Fresno area but also improve the pumping capability at Helms.

And so we look forward to working with the CAISO on any further transmission ideas and opportunities that could then further increase the ability to pump at Helms. Because historically the degree at which we can pump with three unites at Helms has been limited. And to the extent that we can provide additional infrastructure that makes it, the grid, capable of providing that support to be able to pump with three units, the more functionality we'll be able to realize with Helms.

So in summary, as we think about these things, particularly this slide, you know, we need a known, dependable approval path. We need recognition of values of services here, equitable cost allocation. And deploy infrastructure that's going to go ahead and allow for either -- even greater utilization of Helms.

So with that --

MR. BARKER: Questions from the dais? Comments?

COMMISSIONER PETERMAN: I have a clarifying question.

You just said that the ISO has approved some transmission investments in the Fresno area to help with maximizing output of Helms. So right now is there sufficient capacity to maximize all three units?

MR. JONES: So the four projects there were kind of joint functionality, improving reliability for the greater area, and then also enhancing capability at Helms. I haven't seen calculationally that it will guarantee Helms can pump three units every single day of the year. My understanding is it will help. I've actually seen the assets pump with three pumps in pump mode and in the current configuration; right? Right. It doesn't mean we can do it every day though. Yeah.

PRESIDENT PICKER: And those are the midway grid improvements?

MR. JONES: I've got a list of them here that are publicly available. There's a Warnerville-Wilson 230 kV line, Gates 230 -- 500/230 kV transformer. A Kearney-Herndon 230 kV reconductoring. And then a Gates-Gregg 230 kV line, a new line. All right.

MR. BERBERICH: I know the pumps are not variable. Have you explored the -- what it would take to make -- is it even possible to make them variable?

MR. JONES: Yeah. Thank you for asking.

So as we've been doing development on new pumped storage opportunities we also evaluated variable speed functionality. And our initial screening on Helms in a retrofit scenario, the risk-reward profile just doesn't seem to make sense. The actual benefit of being able to reap a variable speed capability in the pumping mode is actually a narrow band of operation. And the work activities that you have to do to be able to get those and -- and the technical changes that you have to do to the facility, very expensive and actually risky to the overall operation of the facility.

So we just -- in our initial screening of that it's -- it just doesn't look like the -- the risk-reward profile plays out. And I could spend more time on greater detail, going through some of the technical discussion on that if you wish.

CHAIR WEISENMILLER: Certainly, let's generalize the question and then suggest in terms of written comments.

You know, it’s -- I know PG&E, a few years back they proposed to use ratepayer money to look at a new pumped storage facility. And obviously the PUC said know. And the question in part is are there are improvements in Helms or some of the other pondage capacity which, again, will give us more flexibility, whether it’s variable speed or anything else. But anyway, that would be interesting follow up.

But just to the extent the PUC is struggling with do they look at new pumped storage, and the question in part is could we squeeze anything more out of either Helms or some of your other hydro facilities?

MR. JONES: Great.

CHAIR WEISENMILLER: That would be the general question. If you can give us a little bit of feedback on that, that would be good.

What’s the capacity factor of Helms at this stage?

MR. JONES: Oh boy.

CHAIR WEISENMILLER: Yeah. Well, again, you could follow up. But, you know, certainly a follow-up on what the capacity factor has been in the last few years.

MR. JONES: Sure.

CHAIR WEISENMILLER: And anyway, if you could possibly distinguish between either, you know, pumping -- you know, either outgoing -- you know, pouring power -- pouring power in or pushing power out, that would be interesting to know too.

MR. JONES: Absolutely.

COMMISSIONER PETERMAN: On a seasonal basis.

MR. JONES: Absolutely.

CHAIR WEISENMILLER: Okay. Great.

PRESIDENT PICKER: And I was kind of interested in your comment, that you're finding that you're doing more midday pumping.

So one of the questions really is: Is the -- is the capacity factor changing over time, and what are the factors that are contributing to the additional functionality of the system --

MR. JONES: There you go.

PRESIDENT PICKER: -- the whole --

MR. BERBERICH: Commissioner Peterman, apparently one of our transmission people are listening on the phone and they have answered the question that the transmission upgrades in the queue are more than adequate to handle the configurations, all configurations of Helms.

COMMISSIONER PETERMAN: Thank you very much.

MR. BARKER: Can you unmute John?

John Dennis, are you there? Can you hear us?

MR. DENNIS: Yes.

MR. BARKER: Okay.

MR. DENNIS: Yes, I'm here. Can you hear me clearly?

MR. BARKER: Yeah. We can hear you. Let me -- just let me know when you want to advance the slide and I'll go ahead and do that for you.

MR. DENNIS: Very good. Thank you.

Good morning to each of you and thank you for the opportunity just to speak briefly today about energy storage. It's certainly an important topic. And I really appreciate even the speakers earlier before us, we learned much as we gathered together and shared this information.

I have just a few slides to share, some of our history of our plant and energy storage, and also some of our current observations of our experiences with pumped hydro.

In the next slide we give a brief item of our history and to share that the facility, Castaic Power Plant, is located just north of the Los Angeles area. And in 1966 the City of Los Angeles Department of Water and Power and the State Department of Water Resources reached an agreement to construct this facility. And the units were built incrementally between 1972 to 1978. As well, though the plant has been in operation during all that time, we saw the need in the period from 2004 to 2013 to do some major repairs. The plant was in some great need of repair and replacement.

And so during that time on our six pump turbines we went through and replaced turbines, starters, transformers, some of our controls, our breakers. And with some of those where had the opportunity within the space constraints of the existing concrete structures, the turbines, we were able to put in turbines that had an increased pump and generate efficiency. So we were able to squeak out just a little bit more out of the plant and to achieve that overall cycle efficiency.

As far as the function of the plant, certainly the state is interested in water conveyance and energy. The state does get the first pass of hydro energy through the plant. For LADWP it’s a great resource and has been for peaking and regulation and reserves.

Specifically on the individual units, we have six reversible pump turbine generators. And then generate mode, we have the maximum capacity of the individual units at 271 megawatts each. And then we also have a seventh unit. It’s a conventional pumping vertical shafted turbine, and that’s 56 megawatts. And that -- that particular unit is currently wrapping up some commissioning work that we’ve done some major replacements. I’ll talk about that in just a moment.

The hydraulic head of the plant is 1,063 feet between the upper reservoir and the plant. And I think we’ll talk about this just near the end as far as some of the lessons learned about that elevation. But also the net dependable output is 1,175 megawatts. We can for a very short duration hit about 1,250 megawatts for the full plant capability. But there are limits on the tunnel itself because of friction losses that are in there, and also depending on the elevation of the upper reservoir at that time where the water delivery is at.

The next slide.

The plant originally -- in the different modes of operation the plant originally planned as a sister to a nuclear plant, the San Joaquin Nuclear Generating Station. That never did come about. Some of you may remember that, back in the '60s. But today, even in the operation, though, even though that didn't materialize it has coupled well with our older thermal units that were in the Los Angeles Basin, as well as other thermal units in our system. And it has also coupled well with -- for peaking and cycling of our facility needs and our system modes. Also for regulation it's been a great help.

Just as far as a typical operation is to have pretty much around the clock, at least one to two units in the condensed mode where motor these units for voltage support. And then for pumping operations, basically there we're balancing the net water flows to work closely to meet the state water deliveries, along with economics and reliability.

So with that, in anticipation as the season changes throughout the year and the needs are there and the water flow changes, we're trying to do the efforts in working with the state to balance reservoir levels with the anticipated system needs which change, again, seasonally.

One of the things on this -- on the facility, it is -- and the pump operation, it's full pump only. We don't have the variable speed capability as was described in the model that was described by the gentlemen with the E3 studies, but that is a 240 megawatt step. So basically there's no sliding variable there for the pump mode. There's no partial pump capability.

Our experiences, as was just shared by PG&E, were similar as far as studying that. When we were doing our retrofits in the 2000 time period we looked at that capability, the cost to put in that -- that feature for variable speed. It has a sizeable space constraint that's there physically. And it would take up some of our much needed space for maintenance of our facility. And as well is the cost effectiveness was a secondary matter, but just physically the space itself was a large piece to this as far as fitting it in the plant.

The -- but certainly we would just say that -- and if -- should there be development in the future, that certainly is a great opportunity to look at that for a new facility. And we encourage that, being -- seeing the great need of flexibility in our system.

For contingency reserves, we -- it provides a great value in spin, as well as non-spin, as we're able to put units on within ten minutes and meeting the reliability standards.

On the next slide, as far as future usage, we see usage similar as past, though our generation portfolio is changing. And perhaps our -- our generation, our pump is going from perhaps what used to be nighttime to the daytime, we're seeing that more. Still, the usage continues for water conveyance above all with the state.

As far as over-generation, regardless of the source we're starting to see, as we phase out the old thermal units and building the new, and here today residing at about 20 to 25 percent renewable energy, we're seeing that the plant has value there, as well as load following, so meeting the ramps and the peaking and the cycling that's necessary for our system dynamics, also for the regulation and the contingency reserves, seeing that that's both a blended solution for regulation.

So as we see new technologies that we're putting in we have some advanced gas turbine technologies. And some of those gas turbines are equipped with clutch mechanisms. And so we're able to blend both usage of our pumped storage, as well as southern parts of our system some of our new gas turbines. And those combine and work well with some of the incoming, both solar and wind, as we see that -- those curves and those characteristics looking very different.

We appreciate the comments earlier that were made about the differences of those characteristics, as well, how these work together, both the solar and wind having different curves, and wind being a more rolling curve and the solar being a steeper curve to catch up with. And so these are, again, great value that these bring.

And then the fleet-wide changes that we're seeing is that we continue there at the facility. We're just wrapping up the Unit 7 refurbishment where we've replaced the turbine, the generator, and some of the hydraulic controls. And that's in test and startup right now.

And then also furthering plant automation will be finished in 2017, though we're basically augmenting some of the earlier retrofits that were done on the units and so that we can maximize the use of the facility.

But all this to say is that L.A. has made some sizeable investments to just keep this resource available to the system, as well as rebuilding our entire fleet for thermal, hydro, pumped storage for operational flexibility for many of these new requirements as we look at the challenges ahead of us for SB 350.

Again, in closing with this, our effort is just to use all that we have there to capture all the renewable, to reduce our greenhouse gas emissions, and to maximize the use of our equipment.

And with that we would also say is that we have a long experience of use with pumped storage. And so should that be considered in the state as far as that need and that particular interest, we see the great merits that have already been presented today, we would just like to make sure that we're offering ourselves. We have learned much from our Pumped Storage User Committee that we've participated in over the years of operation and maintenance. And we'd like to just be available to assist with any technical specifications in the state from years of experience.

And with that, just to say is that the challenges are ahead of us for a clean and proven technology without adding any additional greenhouse gasses. And I think that the pumped storage certainly has a big place in that in our state.

And with that we'll just -- may be available if there's any questions you may have for us.

CHAIR WEISENMILLER: Hi. This is Bob Weisenmiller.

I have one question, which was I'm just trying to get a sense -- I guess I'd start out with just asking again if you either know or could provide the capacity factor over time, that would be good. I remember back in the late '80s I helped LADWP and Edison negotiate a deal where Edison actually got to use one of the units. My presumption is at this point the usage of the unit is much greater than it was at that stage. But again, just trying to understand how close you are to the -- using the whole thing and how it's changed.

MR. DENNIS: The -- well, yes, I think the element there with capacity factor, as we see with a traditional unit and using a traditional unit is different than with the pumped storage, especially because of the difference of -- we can see capacity factor with a generation component. But as far as the sizeable use of regulation and contingency reserves, those aren't going to reflect in the capacity factor piece. So we've got to work on that one and how we communicate the utilization to make sure, I think was commented earlier, that we're just maximizing the use of this of this facility and getting everything we can out of it. And so we'll keep working on that one to communicate that to you with the -- the full utilization of the equipment there.

CHAIR WEISENMILLER: No, that's very good. Now as LADWP moves up from 25 percent to 50 percent do you anticipate this will cover all your flexibility needs or are you going to need to -- you know, at what point does Helms suddenly, you know -- or, excuse me, Castaic not provide you enough flexibility in this area?

MR. DENNIS: Well, with -- with the challenge of a 50 percent portfolio, that's about 15,000 gigawatt hours that we'll have to generate with renewable, we're still working on that particular model to see how that would look in meeting those particular needs. So that still is yet to be determined.

CHAIR WEISENMILLER: Okay. Thank you. Thanks a lot for calling in.

MR. DENNIS: You're welcome. Thank you.

MR. BARKER: Thanks, John.

So now we move to the -- our last presenter on our existing facilities panel.

MS. RODGERS: Good morning. My name is Kelly Rodgers. I'm the Energy Program Manager for the San Diego County Water Authority. And I'm just really pleased to be here today to give you a unique perspective on these issues from a water and agency standpoint.

I just want to give you a brief background on our agency. We were formed in 1944 by state legislature to supply 24-member agencies and pretty much 97 percent of the county's population with imported water supply. We've also developed local water sources, as well. This is a very big job for a couple of reasons, the drought, of course, but also what we're finding is really the cost of energy is really affecting our water rates and our ability to meet our mission to deliver water, safe water with a reliable supply and cost effective supply as well. And so this water-energy nexus issues is very much something that we are addressing daily in our operations.

Back in 2000 Senate Bill 552 granted the Water Authority special authority to be able to produce and sell power.

So with that I'm going to show how we actually -- I think I messed up. Thank you.

So we're actually implementing these authorities. And we have commissioned in 2012 Lake Hodges Pump Storage Facility. This is a 40 megawatt facility. We have a power purchase sales agreement with San Diego Gas and Electric. And mainly what this facility does, it provides the service of being available. You can see here it has two 28,000 horsepower pumps, variable frequency drive.

I want to give you just a quick history is that originally this was not conceived as a pumped storage facility. That was later, and add-on in design. As a water agency our primary function is really ramping up local storage and, you know, delivering water to customers.

At one point in time, water on the lower reservoir is Lake Hodges was owned by the City of San Diego. It has a very large drainage area. When we did get great rains that water was lost over Lake Hodges Dam.

So the Water Authority developed an emergency storage project and this was part of it, and building an upper reservoir owned by the Water Authority, Olivenhain, and a pumping facility at Lake Hodges to pump that water up and control lake levels. And so we did -- what we did do is study adding an incremental capital cost to upsizing this facility to be able to produce revenue to help offset our operations and maintenance costs.

Now Mike and I chatted before when we were coordinating our presentations, and I toyed with, oh, should I leave the duck curve in. And another slide, it looks very familiar. But I think we decided it was a good idea just to really demonstrate how, whether you're an IOU, regulatory agency or a water agency, we're all seeing this and having to it and taking advantage of some opportunity of the belly of the duck, that over-gen, and how we can leverage that and change our operations to be able to use lower costs and help stabilize water rates. And then, of course, you know, the neck and the tail of the duck, the ramping and how we can adjust our operations to accommodate this.

So here is an example of how our operations have changed from concept. We, too are seeing that we're pumping during the day. The gray line is 2014 and the red line is 2015. So you can see, yes, this is affecting us too. SDG&E is our scheduling coordinator during the forecast of the CAISO market a day ahead. And they have been asking us to pump during these times. Now July in the summertime was extremely hot for San Diego, so we did not see this as much. But now we're seeing it more as we get into the cooler weather, but still the very sunny weather.

And here, again, another familiar slide. I just wanted to emphasize, you know, with the RPS standard increasing and facilities like Lake Hodges and PG&E and LADWP, there's opportunities to integrate the integrate the excess renewable in our operations and avoid curtailments, and also, you know, full pumped storage to just meet peak demands and ramp up quickly.

So this highlights all the benefits we talked about before, storing the over-gen, reducing GHG kind of indirectly, but a highly flexible source. We, too, as a water agency are looking at other types of storage and technologies. We're implementing batteries. And we do see, like Mike said, that there are tools for different needs. And we are exploring with our partnership with the City of San Diego a 500 megawatt pumped storage project too. So we're looking at all these different things, again considering that water-energy nexus. And really thinking that power and water go hand in hand, we could develop facilities to help stabilize the grid, but also stabilize water rates, and both are very good for our community and end users.

And thank you for this opportunity. That concludes my part on the panel.

CHAIR WEISENMILLER: Great. Thank you. I'll ask you the standard question. If you could submit utilization information that would certainly be of interest to us.

I was also going to observe, when I've talked to our German colleagues they obviously envy California's much greater solar insulation, but also we just have much more hydro. I mean, they're more like three percent. So they -- they always ask what we're doing to use the existing hydro as part of the solution here, which obviously they -- they don't have. And so having water entities step forward and looking at ways to build in more flexibility or more storage capacity really should be part of the option we're pursuing as we address the PUC's and all of our desires to get a much more flexible load to match the flexible resources.

MR. BERBERICH: Kelly, is your agency looking at any other opportunities for development of pumped storage facilities?

MS. RODGERS: Right now, again, we're studying a facility of up to 500 megawatt with the City of San Diego. Right now we're really looking more at inline hydro and things like that and other technologies, so it's really pretty diverse. Just like we've been diversifying our water supply sources, we're also doing that with energy because they're, again, related.

CHAIR WEISENMILLER: Well, again, thanks for participating today. And we're going to take a break. We're going to start again at one o'clock. Thanks.

(Off the record at 12:00 p.m.)

(On the record at 1:05 p.m.)

CHAIR WEISENMILLER: As I said, we've got a lot of ground to cover and we're trying to do it efficiently.

So, next panel.

MR. BARKER: Okay. Starting with the next panel, and to give everyone the heads-up, if you would like to make public comment at the end of the workshop please see the Public Adviser for a blue card and then -- and turn it into the Public Adviser who, let's see --

CHAIR WEISENMILLER: If you're in the room. And then we'll go online --

MR. BARKER: Yeah.

CHAIR WEISENMILLER: -- of course. Yeah.

MR. BARKER: Thanks. And then we'll go around online afterwards.

So first up -- so this -- this panel is to -- are for potential projects. And really the goal here is to identify barriers to coming online. And just to reiterate to our panelists, we're really looking at five to eight minutes for the presentation, really focusing on those barriers and not -- not necessarily the -- the specific technology.

So let's start with Doug Divine from Eagle Crest. Let me pull up your presentation. There we go.

And do you have the clicker, Doug?

MR. DIVINE: I have the clicker, yes.

MR. BARKER: Okay. Perfect.

MR. DIVINE: Thank you. Doug Divine, CEO or Eagle Crest Energy. We are developing a 1,300 megawatt pumped storage project in Desert Center about 60 miles east of Palm Springs. And I'm going to walk through these slides quickly and get to, again, as I've been asked to talk about, some of what I see as some of the barriers and the potential ways to overcome some of those barriers for large duration of storage development in California.

So again, ours is 1,300 megawatt. It's a brownfield site, closed loop, so it doesn't have some of the environmental impacts that -- that other -- some of the existing projects have. It is designed as adjustable speed technology.

And again, Chair Weisenmiller, just to address some of your issues, the retrofitting adjustable speed technology requires a lot of additional space in the cavern which may not be compatible with certain -- you know, certainly with subterranean caverns.

We did get our FERC license in June 2014, and one of only two licensed pumped storage development projects in California right now.

I'm having clicker problems here. Here we go.

MR. BARKER: Oh, there's an error. Let's see.

MR. DIVINE: So I'm going to talk through --

MR. BARKER: I'm having a hard time with it.

MR. DIVINE: -- on my presentation, again, just the barriers that we have seen.

You know, first of all, we -- we participated actively in the Energy Storage proceeding several years ago at the -- at the Utility Commission and were disappointed when the commission, you know, overlooked pumped storage as a technology at that time that could contribute to energy storage. I certainly appreciate the reasoning that the commission took in that decision, you know, but believed that, as I said, three years ago in that proceeding.

What we're looking for is a playing field for long-duration pumped storage to be considered in utility procurement opportunities. And that's something that we'd like to see. Part of that order talked about asking utilities to bring in pumped storage opportunities. We have talked to the major IOUs in California and, you know, because of they're not being a place, it's kind of a chicken or the egg, not being a place in the procurement process for them really to bring pumped storage they were kind of uncertain as to how to do that. So I think getting some clarity on that from, you know, from the -- from the commission would be useful for allowing pumped storage projects to be valued against other alternatives.

We think, as was discussed earlier, that there is a need for long-duration storage in California. Our project based on final design can provide anywhere from 12 to 18 hours of continuous, you know, output storage at up to 1,300 megawatts.

And so I think the other challenge that pumped storage faces is, as was mentioned by some of the earlier owners of existing pumped storage, it's kind of a long development cycle. Now fortunately we're kind of halfway through that development cycle. We've already got our FERC license. We -- we need to do additional development engineering which is -- and work on the -- on the site. But until our investors and potential new investors can get an understanding of kind of what the procurement process might be it's hard to get them to understand why they should be putting up development capital without some understanding of the procurement process. So we'd like to get some clarity on that. So again, so we recognize a need to kind of compete with other technologies.

Also, again, because of this long-duration process and because there are so few long-duration storage opportunities out there using a proven technology, again, almost all -- I don't have an exact number, but most of the major long-duration energy storage in the world is pumped storage. And right now there are about 20,000 megawatts under construction or in operation in recent years in Europe, Asian, primarily in China, and in Japan. So it has been a part of the solution that those countries, those regions have looked to as they've sought to deal with some of their own renewable and variable energy challenges.

What we would like to, you know, talk about from a proposal, you know, something to offer for discussion is some form of -- because of the size of this -- of this project, the need for kind of multilateral contracts, contracts with more than one utility, which again doesn't fit into kind of the current RFO process. And we think if we look at some of the successful projects built in this state in the past some form of negotiated multilateral agreement subject obviously to, you know, PUC approval and various reviews by PRGs and others is something that the commission should consider and encourage the utilities to talk about as a way to, you know, bring projects that have a large benefit to the system that get them on in today's environment.

MR. BARKER: I'll just give you a heads-up. You -- I've got your slides up now and working

MR. DIVINE: Okay.

MR. BARKER: Sorry about that.

MR. DIVINE: We've -- so again, talking about the barriers, you know, we -- we're -- we also want to continue to work with the ISO in just looking at some of -- you know, again, because energy storage is so flexible it can operate as both generation, and in load, make sure that it's appropriately treated in the transmission interconnection process. We are currently in the queue now.

So again, alternative procurement, again, we would like again some direction for the IOUs to enter into meaningful discussions with, you know, projects such as ours again that, you know, that have their FERC license or at least have some -- again, have reached some standard of -- that they're in kind of advanced development. We would like to do that in a way that, you know, is -- that allows us to have some -- some surety of kind of a process going forward and minimizes risk to -- to ratepayers. Again, we would like kind of, again, the need for the multilateral, perhaps a multi-stage to recognize our development spend against some kind of, you know, target price approach as a way to, you know, bring some certainty to -- to our investors, and protecting ratepayers as well.

We appreciate time is of the essence. These -- again, this project has -- we have about two years of engineering and about four years of construction. So we're at a minimum of six to six-and-a-half years from being in operation which from, again, from some of the modeling that we've done in that mid-2022, 2025 is perhaps a good time for a storage asset like this to come on size -- come online.

We appreciate that we're not looking, that we don't believe pumped storage or large bulk storage is all the State of California needs to solve -- to kind of lead the future in higher levels of renewable development. But we think there is some -- some size of kind of the least regress using a proven technology, you know, that has got a long operating life, both in the United States and around the world, and would like to work with this group to, you know, just to clear up some of those procurement path uncertainties so we can go forward and allow this project to compete with other technologies and other bulk storage projects.

And thanks for the opportunity to come before you and talk about these issues.

CHAIR WEISENMILLER: A couple of quick questions.

MR. DIVINE: Yeah.

CHAIR WEISENMILLER: One of them is, is you talk about various -- multilateral agreements. Have you talked to any of the POUs about participation?

MR. DIVINE: That's a part of what we'll do. We have not done that yet. But you know, we have something that is on our list to do before the end of this year is have some of those initial discussions with him as well.

CHAIR WEISENMILLER: Now the first time I ran across this project I think it was like '96 or '97. So how long --

MR. DIVINE: Well --

CHAIR WEISENMILLER: -- have you guys been at this?

MR. DIVINE: Well, I have been with Eagle Crest since 2009. But the founder of the company, Art Lowe founded -- he found the opportunity at the old abandoned iron mine in the early '90s. And back then I would say it was a solution in search of a problem. But lo' and behold I think, you know, the need for -- for, you know, energy storage to help solve some of the issues, you know, first started to kind of bubble up in that timeframe. And I think again with SB 350 moving toward 50 percent, this is a technology that may make sense at, you know, at a few unique sites in California and the West.

CHAIR WEISENMILLER: It’s certainly taken a lot of time. I don’t know if you have any ability to give us a ballpark. How much did it take to get you here?

MR. DIVINE: Well, again, it was done by an entrepreneur. And so it was -- I mean, to date the company has spent, you know, less than $30 million in costs to get it permitted, and again, that’s with a full FERC license. Now again, if you look through the numbers, we actually filed our final license application before FERC in 2009. So it took us five years to get a FERC license from filing the final license application which is, if you talk to others, that’s kind of even on the -- on the quick side for FERC to act.

CHAIR WEISENMILLER: Okay. Thanks.

MR. DIVINE: Thank you.

MR. BARKER: Our next panelist will be Fred Fletcher from Burbank Water and Power.

Let me pull that up. You need to turn on your mike.

MR. FLETCHER: (Off mike.) Oh, the mike. Right here?

MR. BARKER: Yeah, right in the middle.

MR. FLETCHER: Very good. Okay. Good afternoon. I’m Fred Fletcher. I’m Assistant General Manager of

Burbank Water and Power. Burbank Water and Power is a public-owned utility. It’s in the Los Angeles Department of Water and Power balancing authority, so it’s not part of the CAISO. We have set a goal back in 2007 of 33 percent renewable by 2020 and we have achieved that. And we try to do that without any increases greater than the rate of inflation and we were able to do that.

So we started a few years ago in 2012 to see what we were going to do next to take -- for the next level forward. And to avoid the horizon issue that you can have by -- by not having a far enough scope, we wanted to see, could we go to two-thirds or something higher than that level of renewables, what we would need to do.

So we had a time that we’re looking at the Intermountain Power Project which is our largest source of carbon. And it was going to be retired in 202, so it looked specifically at how we were going to replace that plant with a plant that could be largely renewable and a very minimal use of coal. If it could do that, that would fill about 50 percent of our portfolio, so it would be a big step.

So we’re working with LADWP on finding ways to change that plan out, and in doing that in 2009 we found a huge salt dome underneath the project. And we started looking at what we could use that salt dome for and I found some interesting stuff. And it’s something that could potentially scale and have an effect, so let me explain what that is.

We've entered into a relationship with Pathfinder because they are able to fund this better than Burbank Water and Power Can. But this is -- sorry. This project is literally right at the Intermountain Power Project site, under it, about a mile deep is this large three-square mile salt dome. And it's capable to put 90 manmade salt caverns in there that are each capable of holding 2 to 3 days of storage for 300 megawatts in each cavern. So you can see, together that would be in excess of 25,000 megawatts. So that's -- that's a big facility.

It's -- we aren't looking at anything nearly that big. What we're looking at is two phases. The phase one would be a 320 megawatt plant. And it could be then followed by phase two which is a 1,500 -- 1,200 megawatt plant, for a total of 1,500. We're having it being in the front-end engineering and design stage right now, so we'll have those specifics in a few weeks on what the engineering is with that.

The parties involved with it are -- not working there. There we go.

Dresser-Rand is the manufacturer, and their owned by Siemens, they're helping us on there. Pathfinder is involved with this. And Pathfinder has got Navigant

Consulting, and California Environmental Associates is helping us with it. Then we've got Duke Energy-ATC on the transmission side. Sammons and Guggenheim are helping finance Pathfinder, as well as some legal support from these firms, plus some others that I -- Intermountain Power Agency. Okay.

The Burbank Water and Power is -- operates power plants, not only for itself but for other parties. We have the Magnolia Power Project, which is actually located right in Burbank, which provides power both to the CAISO and to Burbank and Glendale within the L.A. area.

We also operate the Tieton Power Plant up in Washington which is a plant that is one of the river hydroelectric up by Mount St. Helens. That's for Glendale and Burbank.

Our transmission grid does go with Los Angeles and goes out throughout the West quite a bit. And so it gives us a chance to do things to help influence other areas. And influencing is an important thing for making change. And I think making change on a global basis is going to be very vital for the greenhouse gasses.

So we have been part of the Pacific Intertie for -- ever since it was put in service back in '71. We've been part of the Southern Transmission System which goes from Intermountain Power Agency down to Atalano (phonetic) since it went in operation in 1986. And the Phoenix meet Atalano Project that goes from Phoenix to Vegas into L.A. when it when in service in 1993. But using those resources we -- we have a rather limited geography because it's only the things that can get on that line that can get us home the best to help us use our transmission.

So we looked at the compressed energy storage and we've got a few numbers that will show you how it -- how it improves bringing in renewables. This -- I'm not going to dwell on the numbers because that's not what you asked me to do. But it's here in case someone is interested in looking at that. Basically, compressed air, because it can handle both the load and the generation, can do more than what just simply generation can do.

I think what's important here is that we've looked a lot at what we could do with distributed energy resources because that's really important for a POU because we -- that's in our neighborhood and that's really an easy one to do. But it doesn't appear to be enough to get the thing done reliably, particularly considering when we did some production runs we found that we'd get in trouble if we don't have like two or three days to get through during some times when there's not enough -- there's no enough wind.

The other one we have is a comparison of compressed air energy storage versus combined cycle generation. We like combined cycle. It's -- it's much more efficient than -- and more responsive. But compression energy storage has a surprisingly rapid ramp rate. And you can also only have to operate as a generator half the time. The other times you're operating as a load and so you're -- you're not really generating as much thermal. So it does overall give you some better attributes for what we're trying to do.

And basically, we all know with SB 350 we're going to have a lot more capacity that we could put into storage which, again, adds value to storage because it can capture this value.

And we've gone through and looked at the economics. We find that it is difficult to avoid these subsidies across -- we -- the markets are not friendly to something that -- there could be a lot of free riders that could occur in the current market structure.

So -- but Burbank is a vertically integrated utility, so we can capture those now. So it allows us to maybe move forward with a small project, like a 300 megawatt one, and be able to devise it's value so that some of the barriers to entry that I want to talk about can be addressed in a reasonable time with some prudency.

The -- these are the challenges that we're facing. Compressed air energy storage is generally not part of policy discussions. It’s not very well understood. And so we will -- we will be able to provide to the market some studies and some ideas how this might be -- we’ve done some work with GridView, we’re hoping to have some stuff with Variable speed, and how this might work with CAISO data so that we can understand it better so that it can be part of the general discussion. The regulatory treatment of storage is uncertain. And the more we dig into that the more issues we find.

The thing that is another one is that it by nature is interstate. And so being interstate we get the complexity of how things are done on an interstate basis. We did this study in the long term, we looked at Wyoming Wind. We chose the Wyoming Wind because it was -- its price. But as we dug into it and we started to work closer with PacifiCorp, as well as -- we saw that it might give the benefit to even change some of the coal decisions that those companies have. If we can make renewable energy cost effective in the West it might change the use of coal in the West. And so it’s -- it’s something that we think has whole West-wide implications. Again, this isn’t going to happen overnight. But by bringing the cost down for renewables and making it so they’re dispatchable it’s going to make renewables more attractive.

That’s all I’ve got.

CHAIR WEISENMILLER: Thanks. We certainly appreciate Burbank taking a leadership position on storage as part of its push on renewables and dealing with greenhouse gas emissions. You know, it's -- where this will play out, you know, is sort of interesting. I mean, we had a conversation before we started, obviously most of the compressed air projects in California itself have had technical problems.

But I guess the one question, the salt, I mean, we might also -- it's really a fortuitous find on your part. You might offer it as a waste solution for some of the San Onofre issues.

COMMISSIONER PETERMAN: On slide seven, I mean, you give a number for the Co2 emissions utilizing renewables. What's your renewables assumption there?

MR. FLETCHER: What's my renewables assumption?

COMMISSIONER PETERMAN: On slide seven you give a .3 ton per megawatt hour number for Co2.

MR. FLETCHER: Oh, yes. That comes from -- the way a compressed air energy storage plant works is that when you compress the air the air gets hot, and so you lose that heat to the atmosphere and that represents a loss. And then to recover that you take natural gas or propane and you use it to replace that lost energy, and that's the carbon.

COMMISSIONER PETERMAN: Okay. But then you have a footnote saying you get to .3 tons utilizing renewables. What’s your renewables assumption? Is it --

MR. FLETCHER: Oh, the renewable assumption that we did on this study was Wyoming Wind. Yeah, 3,000 megawatts of Wyoming Wind coming down the Duke Zephyr Line.

COMMISSIONER PETERMAN: Okay. Thank you.

MR. BARKER: Okay. Next we are going to go -- our next speaker is Joe Eberhardt from EDF Renewables.

MR. EBERHARDT: Good afternoon. My name is Joe Eberhardt. I’m with EDF Renewable Energy. We are a wholly-owned subsidiary of Electricite de France operating here in the United States, mainly producing wind energy and solar farms, developing those projects. I’m leading the effort on looking at pumped storage and developing one of the major projects here in the WECC from pumped storage called Swan Lake North.

Can I have the clicker?

The EDF Renewable Energy is based here in California. Our headquarters is in San Diego. We have almost approximately 400 employees working within the state. And we developed several wind and solar projects here in California, as well as throughout the United States.

MR. BARKER: Here, I got it.

MR. EBERHARDT: That should advance the slides?

MR. BARKER: Yeah.

MR. EBERHARDT: How's that?

MR. BARKER: That will work.

MR. EBERHARDT: Okay. Thanks.

Our experience in pumped storage comes from our parent company, Electricite de France. We have been involved in the development of pumped storage for 23,000 megawatts of capacity across the world, primarily throughout Europe in the backyard, as well as parts of Asia.

We have a Center for Excellence for hydropower, both traditional and with pumped storage with over 1,000 employees at that center, of which 600 are dedicated engineers to hydro. So we have everything from metallurgists, mechanical engineers, electric engineers, civil engineers, you name it. All they do is hydro. These folks have decades of depths of experience.

Most recently the company has developed two pump storage projects, one in Morocco and one in Israel, which are sister projects to our proposed facility here in the United States, same size, same technical characteristics.

And what we're looking to do with all of these new projects is to find ways to bring down the cost and bring the most modern technology to the facility. So we are using the variable speed technology that's been discussed today already, and new ways of optimizing the conveyance systems which in these two projects that I'm referring to, as well as with Swan Lake North, these are above-ground penstocks, so very similar to the Castaic System. As such we avoid the geological risk and uncertainty of developing underground powerhouses which is more of a design like the Helms Project that was discussed earlier.

Next slide please.

MR. EBERHARDT: Some details on our projects here in the United States. Swan Lake North is located in Southern Oregon just across the California-Oregon border. The size of the project is approximately 400 megawatts, a little bit less for generation, a little bit more for pumping. We have a very large head of the project which creates great efficiencies for the generation of electricity at just over 1,600 feet of head.

The project is located in combination of private and BLM land. We have private water rights that come from groundwater. The facility itself is not interconnected to a river or to a lake of any kind. It has two brand new manmade reservoirs that provide the housing for the water. And as such it is a closed-loop system.

The location here in the southern part of Oregon is actually very vital in trying to develop price savings between the energy that is pumped into the facility. We can take advantage of energy from the Northwest that at times of the year is cheaper, and then provide that energy in a generation mode and through ancillary services during peak periods to California. Alternatively, we can move energy out of California during the solar surplus that's been depicted today, during midday, and then return it later when it's needed as well. So it's a very vital location for trying to get the most efficiencies out of the markets and the energy and pricing of that energy that is available.

Next slide.

Getting to barriers. I think the chief barrier that I have seen related to pumped storage and for our project at Swan Lake North, this is not any different, the -- the size of the projects themselves speak to having a procurement by more than one entity. And so we end up with a situation where we need to have potentially multiple offtakers or multiple entities involved in the procurement process in some form.

What I show in this pie chart here is a breakout of the benefits that we have modeled related using the PLEXOS software for the Swan Lake North Project. And in this case geography and location are very important with regards to the distribution of benefits. The two chief benefactors are PG&E and SCE relative to our project near the California-Oregon border. And there are several other benefactors throughout California, as well, including LADWP.

What I think needs to happen is a form of direction given by CPUC in the case of these two load serving entities that are IOUs, but potentially maybe even something more broader because the benefits are kind of shared by everyone throughout the CAISO and throughout California for projects like these. And finding a way to have a sharing in that procurement process and in the costs associated with it I think is the chief barrier that I'm seeing related to acquisition of pumped storage. So joint cooperation and procurement I think is critical.

Next slide please.

So as it relates to processes that are out there now, we're looking at what is the other 50 percent. Clearly pumped storage is something that fits into that.

Other folks have spoken today about the need for long-duration storage. I was interested to hear the eight and nine continuous hours of storage require from the, I believe, from the CAISO study or from the 3E [sic] study. Definitely that speaks to the core competency of pumped storage.

These projects also have the ability with the new variable speed drive technology to provide ancillary services during the pumping mode as well. And one thing I'd like to highlight about our project, the technology we're using, and this actually has a full start generation --

excuse me, full output of generation to full output of pump, so a full reversal of cycle in less than three minutes. So you have a very short turnaround. We have approximately 200 megawatts per -- per minute of ramping capabilities. These are very high speed projects. Our particular unit -- particular set of units uses a higher RPM unit than what traditionally is used. They're lightweight and it allows them to be even more flexible than other types of variable speed generators that may be larger in capacity per unit. Ours are as little as 131 megawatts per unit which allows them to be a pretty quick turnaround.

Viability in looking at procurement I think is critical as well. As we look at how we're going to fulfill the other 50 percent, if it is going to include storage we need to ensure that the technologies that are used are viable technologies. And in looking at how to plan ahead for incorporating those viable technologies into procurement, pumped storage, as has been said, is a long lead time development energy project. And so looking ahead seven years as opposed to maybe four or five is the kind of requirement to be able to season this technology and take full advantage of it in the planning process.

Thank you.

CHAIR WEISENMILLER: Yeah. I guess the thing I don't understand is obviously the BPA system has tons of hydro but they have very little storage. And so a phenomena for decades has been that when spring floods occur they can even, you know, just spill the water or they can sell it to California at whatever price they can get, which is often very small. So I would think this might be a way for BPA to firm up some of its hydro system to get more value than what they can get as -- in their spill or whatever conditions. So -- but I didn't see them on the chart, and it's not obvious you've been talking to them about participation.

MR. EBERHARDT: That's a very good question. What I have seen in the modeling related to BPA is actually there's a bit of cannibalism, if you will, going on. We provide ancillary services and peaking generation which is the same thing that BPA's existing dams do. So when you look at the net benefits across the existing dams that Bonneville controls, the benefits they would receive from storing this spill water through a project like ours, plus the round-trip transmission costs to get it to the project from the mid-Columbia area is offsetting. So it's -- it's really not a game or a loss for them. It's just something that's more of a neutral benefit.

So barring a change in their operations that would have more of a driving force than the economics of the spill water, it doesn't have the same benefits that I'm seeing for the California entities that I showed.

CHAIR WEISENMILLER: Thanks. Anyone else? Okay.
Thank you.

MR. EBERHARDT: Thanks.

MR. BARKER: So next up we have Michael Katz with Advanced Rail Energy Storage.

MR. KATZ: Greetings everyone. I'm representing Advanced Rail Energy Storage, and we're known as ARES, and we're basically pumped storage on wheels.

And if you could flip through the -- some of these -- the next slide here.

MR. BARKER: Which slide do you want to start on?

MR. KATZ: Or I can take the clicker. Is that an option?

MR. BARKER: Start show. There you go. Go for it.

MR. KATZ: So I'm going to focus a little more on the challenges of development, but I'll just touch a little bit upon what the technology is. Pretty much ARES technology moves weights up and down hillsides or mountains, as long as there's about 1,000 vertical feet of difference. It's actually fairly efficient. You can get a 78 percent round-trip efficiency out of the technology. And like pumped storage, the scale is large. It's not very economical to build a small-scale project. You really need to be in a larger scale to be economically attractive.

Could you move to the next slide? Great.

So right now ARES is working on a project on the edge of the CAISO system in Nevada. And it is a 44 megawatt facility generating 57 megawatts on charging. And it will be a regulatory energy management project, so pretty much just providing reg up, reg down to CAISO grid. The target to have it online is in 1990 -- late 1999.

Can you move to the next slide? Great.

The -- some of the areas technology is it's scalable. So you can add increments of capacity or increments of storage to it. There's a lot of site options as long as you have about, again, 1,000 vertical feet you can have apply the technology. It has a variable output, but the efficiency of the dispatch stays relatively constant. And I mentioned that it's relatively -- has a relatively high round-trip efficiency. We think the (inaudible) cost can come under pumped storage.

The great thing about rail technology, it's a very mature technology. This is just a new application of rail technology for energy storage purposes. It doesn't use any water, there's no emissions associated with it, and there's no environmentally troubling materials like lithium extraction, for example.

Next slide please.

So some of the hurdles for the ARES Company are the following. For this ARES Nevada Project financing will naturally be a challenge. And because this will be in the regulation markets, trying to figure out where regulation prices are going in the future is a key issue. And we have forecasts, and it looks like the revenues from the market are adequate to support this project. However, there's a lot of uncertainty to these prices, and I'll talk about that a little bit later on and particularly the way the CAISO will implement for Rule 755.

The -- from a longer term perspective it's very important for a company like ARES to get a demonstration project with the storage element of it. This -- pretty much the -- the Nevada project is just really going to have a train zigzagging up and down the hill, providing regulation. The more sophisticated technology where you're loading and unloading weights, nobody is going to pursue that unless we can pull off demonstration projects. And we're in talks with three utilities around the United States for a prospective demonstration project. For those type of projects long term contracts are necessary or you would build for a utility and then it would get put into rate -- rate base. And finally, being a startup, the goal is to stay funded through this process.

Moving on to the next slide.

So some of the challenges for development, for the

ARES Nevada Project the real challenge is -- is what regulation prices will be in the future. And what I put up on the chart up here is just showing that right now the accuracy of the existing portfolio of regulation units is really not that great. It ranges between 40 and 60 percent following AGC's signals. So this was pulled, I guess from November 11th off the CAISO OASIS site.

So one of our concerns is, is that if you want fast units that are very accurate in following signals, you know, do the prices reflect the value of the product out there? And I won't get into that because that's a very long discussion.

Moving into the next slide. Oops.

The -- as a lot of other speakers have discussed is the size of the projects are very important for bulk storage. And I just put up a chart showing that the energy procurement targets for the various utilities are pretty small blocks of capacity. And for bulk storage these aren't really the -- the quantities that would be attractive to develop large scale storage projects.

Next slide.

And naturally a challenge is project development timelines. If you are going to participate in the RFO process it's pretty much the RFO process from the time you start competing to getting a contract is probably around two years. But where you need to start moving earlier is to be successful in RFOs you pretty much should have your site selected, probably some engineering design done, environmental impact reports just to show that you're a viable candidate in these RFOs. So by the time you stretch this out it's a very long lead time to successfully procure a contract through the RFO process in California.

And what I'll do is I'll close with that and open it up to any questions.

CHAIR WEISENMILLER: Yeah. I actually -- well, just to remind both Commissioners that you've had a history in the PG&E Gas Department. So they may have questions for you on other topics.

MR. KATZ: But I was in generation most of my career.

CHAIR WEISENMILLER: Yeah. But I remember your last assignment there.

COMMISSIONER PETERMAN: I just wanted to ask you, you mentioned what was needed for a large demonstration project. Are there any in the world that have demonstrated that capability?

MR. KATZ: Not yet. And so we are talking with three companies and hoping to get some co-funding from the state or DOE to demonstrate pretty much storing the waste. So this is a variation, a little more sophisticated variation of the project that's currently being proposed for the CAISO grid.

MR. BARKER: Okay. Our next presenter is Alex Morris from the California Energy Storage Alliance.

There you go.

MR. MORRIS: Hi everybody. I'm Alex Morris with the California Energy Storage Alliance, and thanks for having us here today. As many of you now, CESA is focused on storage all the time. We're a nonprofit and we're -- we think storage is going to be key to pitching in and helping with grid challenges and environmental goals.

As the policy director, you know, we work with this stuff at your variance agencies and organizations. And so I tried to just tee up some actionable ideas to discuss.

And one thing we noticed is that, you know, we probably could have started this list a week ago and it would have the idea of having sort of a public meeting to discuss this, but we can check that off now. So thanks for getting this meeting together. I think it's a great idea.

And looking ahead, though, we -- we still think there's a lot of room for action. And this reflects a lot of the input you've probably already heard. When we look at we think the PUC is really well positioned to sort of coordinate state or agency actions to address these barriers. And there's some proceedings up and running that would fit well for incorporating feedback on that. And we also hope that there will be a chance to add to the record of those proceedings, some of the feedback you got today.

And then when we look ahead at what the agencies or players could do we think that it’s important to consider a longer look ahead. And so I know the ISO deals with this, which is that as you -- depending on how far ahead you look you make very different decisions in who you commit and what you choose to bring as a resource to make sense. And so looking ahead -- and these situations can -- can change the calculus.

We also think that it’s going to be important to consider and promote different contracting and cost allocation methods. And I know you’ve heard that, but historically multiparty contracting structures have been used in California. They’re used for public infrastructure. And if you consider these resources to be of that type then those types of contracting mechanisms can make sense.

And then we’re also looking at the valuation piece. And what we’ve seen is that maybe we want to do some special studies on this because the conventional study processes don’t always reveal the full value from our point of view. I think an example would be the TPP, the transmission planning process, can do a study of what sort of public infrastructure projects would be economic for everybody. But they won't necessarily always look at generation projects because those are deemed to be merchant. And so by having that dividing line you can't always see what really is in the best interests of everybody. And that's a function of the jurisdictional sort of structures we have in place and it makes good sense. But that's why we had teed up this idea of a special study to look at both the integration benefits and sort of the economic effects collectively.

It also sort of brings to mind the RETI process where we're looking at what transmission might be relevant to achieve these environmental goals. And at the same time if we thought about incorporating the integration piece, you know, would you have a different outcome for what you think is appropriate on the transmission piece?

So those are some of our ideas from CESA. And I'm happy to answer any questions.

CHAIR WEISENMILLER: Yeah. A couple. A couple.

Obviously, the -- many people pointed to the PUC storage goals. When we have had under the Skinner Bill, the POUs file with the Energy Commission what they have looked at and what they are planning in storage. And the bottom line, there's not much action there. And so I was trying to understand how much your organization is focusing on the

POUs?

MR. MORRIS: Yeah.

CHAIR WEISENMILLER: Apologies, obviously, to Burbank who's taking a leadership role here. But I mean generally looking across the landscape.

MR. MORRIS: I wanted to -- I'm sorry, saying all that, we had met with SCPPA earlier this year and we're scheduling meetings with NCPA. So we're doing some outreach with them. I'm hesitant to speak for them, but our meetings with SCPPA were a full day of meetings. And generally I heard both enthusiasm and skepticism about the role of storage and whether it was timely for procurement there. So --

CHAIR WEISENMILLER: Yeah. Well, there's something like 40-some POUs in California. There's 16 that are covered under SB 350 that will start working with us on some sort of IRP process. And certainly as part of an IRP, looking forward to people looking at the tradeoffs of storage compared to some of the other advanced technologies. But certainly encouraging you to focus in some of those other forms as opposed to, I was going to say, just the PUC.

MR. MORRIS: Great. Thank you. Great idea.

PRESIDENT PICKER: And I think that because the CEC offered to host the meeting here today, and because of Bob's very specific role with the POUs, I think he's sending you the signal that he's volunteering to take the lead here.

CHAIR WEISENMILLER: Well, I think the legislature has elected us for that or drafted us for that role under 350, much to some of the POUs chagrin, shall we say.

MR. MORRIS: Congratulations.

PRESIDENT PICKER: I'm waiting. I will follow you.

CHAIR WEISENMILLER: Well, actually, I thought you were talking about how the notion of IRP looking across on (inaudible).

PRESIDENT PICKER: No. I was -- I was looking at his first bullet point.

CHAIR WEISENMILLER: Okay. Good.

COMMISSIONER PETERMAN: Thank you.

CHAIR WEISENMILLER: Thanks.

MR. MORRIS: Thank you.

MR. BARKER: Thank you.

So that concludes our proposed projects panel. Thank you very much everyone.

Going right in, we're actually right on schedule. We have our next -- our next panel is our agency panel. And we have the Public Utilities Commission. Neil Reardon is filling in for Molly Sturkel today. Mark Rothleder is going to be giving the CAISO perspective. And then via WebEx we have FERC With Matt Buhyoff and Kyle Olcott participating.

COMMISSIONER PETERMAN: So as everyone is coming up, I have a question. Is there anyone from San Diego Gas and Electric here? Well, to the extent that the utility is present I was curious if they could offer in the public comment period any information about the flow battery demonstration project that they're undertaking with NEDO, I'd be interested in just hearing a little bit more about that. And if they're not present, if you could file comments as a part of the comments on the workshop with just some information about the status of that project and the potential for that as a long-duration asset. Thanks.

CHAIR WEISENMILLER: Yeah. That would be good. We actually funded a flow storage project that's on our website for storage.

COMMISSIONER PETERMAN: Okay. Great.

CHAIR WEISENMILLER: Unfortunately, we started with -- the press conference talked about how it showed as economic. And then in a matter of months they announced the company was for sale publicly.

COMMISSIONER PETERMAN: Fair enough. Well, we'll be looking forward to your insights on that as well.

MR. REARDON: Good afternoon. My name is Neil Reardon. I'm an analyst with the CPUC Energy Division. It's been a great discussion today. And I just hope to frame this in terms of our existing planning and procurement mechanisms.

So I'll quickly give an overview of the long term procurement planning proceeding, the LTPP, give a snapshot of kind of the current state of affairs regarding storage, look at the existing fleet, and then end the discussion looking forward at barriers to development, some of which we've already heard about today.

So the LTPP is what we call an umbrella proceeding where we consider all of our needs for procurement under one vehicle. And really it exists to ensure reliability. It does that by looking ten years into the future from the perspective of system needs, local needs and, more recently, needs for flexible resources.

If and when a need is identified the next step then is for the commission to authorize through decision that the utilities issue and RFO to procure to meet that need. We'll talk a little bit more about recent authorizations later.

So the state of affairs regarding storage. The 2014 LTPP evaluated the need for system and flexible capacity and did not identify a need. Now there's an important nuance here. We didn't say there is no need. What was said was that there was not sufficient evidence at the time to authorize procurement to meet any need. Of course, the LTPP has historically been a biennial process, so we’ll continue to evaluate needs going forward.

In the 2014 LTPP, however, some of you will be pleased to remember that pumped storage was mentioned as a resource that could be used to meet flexibility needs. And that proceeding decided to focus on improving modeling methodologies so that we would better understand in the future what needs we have and the characteristics of those needs. Of course, there’s an existing storage target through that landmark decision which I won’t discuss any further.

So here’s a view of our capacity assumptions by source going forward. And I won’t get into the details, but we can see a relatively flat demand forecast matched with a declining supply, mostly based on retirements from OTC units and other facilities.

So this is a snapshot of the authorizations that were made in the Track 4 SONGS decision. And we see it’s broken down by SCE and San Diego. And you’ll notice that there’s authorizations made. There’s minimums and maximums for various technology types. Also not shown is that that decision ordered the utilities to procure resources at substations that were most effective to offset lost capacity from SONGS. And you know, compared to an LTPP authorization of eight or ten years ago, this is much more granular. I mean, in the past we would have said something like, you know, you're authorized to procure 1,000 megawatts of all-source procurement at the system level. And we see here an evolution of sorts towards much more granular authorizations which I think is appropriate, especially as we move towards an IRP world.

So talking about the barriers to deployment of bulk storage, we've heard today about large up-front costs and costs that need to be recouped from an asset whose long lifetime doesn't match up well with most existing contracts. There's also very specific land requirements. Many of these facilities we've heard about, it's predicated that they exist at a specific site which, of course, limits their -- their flexibility, not flexibility in terms of flexible needs, but flexibility in terms of where they could develop the project.

Finally, one that I think is really interesting is we're talking about developing an asset that benefits the entire grid. And the question of how to allocate those benefits and costs to various ratepayers is an important and challenging one, which I think it's very important to get that right going forward.

Finally, one which was brought to our attention in meeting with some bulk storage developers was, I think the line was something like, "Most people who have worked on these projects have now retired." And I do think it is --

it's a real thing that there is not a great amount of institutional knowledge and recent experience in developing these projects compared with other resources.

I was going to end with an opening for feedback from the audience about other barriers, but we can have that in the Q&A session.

That's all I have. Thank you.

CHAIR WEISENMILLER: Thank you.

MR. BARKER: Okay. Next presenter is Mark Rothleder.

MR. ROTHLEDER: Thank you. I don't have a slide deck. I kind of used all my information earlier.

But what I will say is that we participated in the long term procurement proceeding. And that proceeding largely deals with kind of traditional planning reserve margin, installed capacity. It has over the years developed a methodology for assessing flexibility.

I think in this last cycle of the long term procurement proceeding what started to emerge is this notion of how do we maximize the utilization and the use of those new resources? And that was the question about potential over-supply and reducing that risk of curtailment.

And at -- I don't think the long term procurement proceeding to this point has a methodology to really deal with that type of need. And so I think that's what we see as potentially going forward is needing. And I think the -- in light of the SB 250 we now have an opportunity to create a vision considering all the solutions and put all those solutions on the table and say what -- what do we really want to strive for and what does best fit really look like?

Now along the way, while we may have that vision of best fit I think the process also has to take into consideration it's -- it's a long time to get there. And we need several check-in points along the way to assess progress and efficacy of what decisions we made along the way and determine if we need to make any adjustments along the way in light of either technology, innovation changes, costs, and again the efficacy of what was already put in place.

But I think without that vision and without those check-in points to make adjustments to the decisions, I think you'll always be in this loop of saying what do we do? How do we make the best decision about things that we know today when we know thing are changing over time? And maybe that vision is where the ISO can help inform what that vision looks like, trying to, not to say optimize, but look at the set of solutions and help inform which solutions, at least from an operational perspective, are most effective. And then overlay that with other information about costs, timelines and so forth. And then you can feed that into a regulatory process to create that vision and create the follow-up process to make adjustments to meet that vision.

So that's my -- my thoughts about what's needed going forward to try to assess bulk storage. I think the vision does have a role. Bulk storage has a role in that long term visions. Exactly how much, when do you act on it, and so forth, that's the questions I still think are still to be discovered. And we look forward to doing some of those studies to inform that.

MR. BARKER: Okay. For the next presenter can -- can you un-mute?

Matt, can you hear me?

MR. BUHYOFF: I sure can.

MR. BARKER: Okay. Let me pull up your presentation. And I'll run it from here, so just let me know when to go to the next slide.

MR. BUHYOFF: Okay. Thank you.

MR. BARKER: Go for it, Matt.

MR. BUHYOFF: Okay. I'd like to thank everyone for having us today. My name is Matt Buhyoff. I'm an Aquatic Biologist with the Energy Regulatory Commission. I'm joined by my colleague, Kyle Olcott.

Next slide.

To give you a quick idea of what we'd like to talk about, we just -- a quick introduction to who FERC is what do we regulate, I'll talk about the Hydropower Program in a little bit, the types of authorizations we issue here in DHL, our licensing processes, some considerations that go into that licensing, how some other laws and regulations fit in, and then finally provide some resources for further information.

Okay.

So what does FERC regulate? Well, FERC regulates electric transmission, hydroelectric projects, natural gas and oil pipelines.

Okay.

The commission is composed of five members that are appointed by the president under the advice and consent of the senate. There are seven main offices. We're in the Office of Energy Projects.

Okay.

Within the Office of Energy Projects there are two primary programs, Gas and Pipelines and the Hydropower Program.

Okay.

The Hydropower Program has three main divisions. Like I said, we're in Licensing. We have a Compliance Division, and then a group that ensures dam safety. And we all work very closely with the licensees, resource agencies, tribes, NGOs, and local stakeholders.

Okay.

Who do we have jurisdiction over? Well, FERC has the exclusive authority to license most non-federal hydropower projects located on navigable waterways or federal lands or connected to the interstate electric grid.

Okay.

So we license all manner of hydropower projects, everything from conventional projects, you know, your typical dam, reservoir, bypass reach.

Next slide.

Some also -- some newer technologies, marine and hydrokinetic projects.

Next.

And then something that falls into the focus of your working groups today, the pumped storage projects.

And next.

So here we've just included an informational slide that shows the FERC licensed pumped storage projects throughout the United States. As you can see the majority of the -- the current licensed pumped storage projects are on the East Coast. And many of those are associated with nuclear power facilities.

And next slide.

So here's a map of the issued preliminary permits for pumped storage projects. Now these are essentially conceptual projects at this stage. But as you can see there's a notable shift to the West Coast. And we noticed that in most cases these are the -- the conceptual projects are associated with existing wind and solar energy facilities.

Okay. Next.

So for California specifically we've just provided a listing of the existing pump storage facilities in California. We've given their name, and also their location and the -- in the county they're located in, in parentheses.

Okay. Next slide.

So I'd like to talk a little bit about our division, the Division of Hydropower Licensing or DHL.

Next slide.

We're divided into six regions geographically. Like I said, Kyle and I work in the West Branch, most of our projects are in the California and Intermountain West.

Next slide.

We issue three primary types of authorizations. We issue preliminary permits. And preliminary permits maintain the priority of an application or site for three years, with the option to extend to five years. Now preliminary permits do not authorize construction.

We also issue licenses. Licenses authorize construction and operation. And those licenses are issued for 30 to 50 years. In some cases we issue exemptions for projects that are ten megawatts or less.

Okay. Next slide.

So these are our three licensing processes that we use. Again, you know, regardless of technology, hydropower technology, the integrated licensing process, the alternative licensing process and the traditional licensing process, the ILP, integrated licensing process, is our default process. It’s fast moving with a discreet timeline and includes a lot of FERC involvement pre-application. And it’s typically the most staff intensive, both for FERC and the licensee.

The traditional licensing process is probably our second most used process. The pre-filing stage, the consultation and the study development is driven primarily by the application with little FERC involvement. It tends to be a lengthier process, but it’s also less staff intensive. And we’ve noticed that many pumped storage projects have been utilized in the TLT, and partially because they tend to include some less complex issues that we’ll run into with, you know, with flowing water, with some of the more conventional projects.

Okay. Next.

So here’s a quick visual representation of the three licensing processes. Again as you -- as you note, the TLT tends to be the lengthier process. Like I said, FERC doesn't get involved typically until after the application stage. So sometimes additional studies are needed after the application is filed and the TLT. And like I said, the IOP is our shortest, most intensive process.

Next.

So regardless of -- of the process used, these are the basic licensing steps. It usually starts when the applicant files a Notice of Intent or pre-application document, we call it a PAD. Obviously, we love our acronyms. So the PAD summarizes all the engineering, economic and environmental information that's relevant to the license and the power -- project, excuse me. It's also the foundation for issue identification study development and our FERC NEPA document.

After that issuance the applicant is required to consult with agencies, stakeholders and tribes. And through consultation they identify issues, information gaps and study needs regarding the potential -- potential effects of the project's proposal. And at that stage they'll conduct studies to fill those information gaps. And studies are often needed to evaluate engineering, economics and environmental issues.

Next.

So second stage of licensing is post-filing. The licensee will file an application. Agencies and stakeholders have an opportunity to comment on that application. And agencies will submit recommendations, prescriptions and conditions. At that stage commission staff utilizes the NEPA process to analyze the effects of the project proposal, agency and other comments and conditions, and staff will make recommendations to the commission. At that point the commission will utilize the project record to -- to make a licensing decision. And that licensing decision is -- is whether or not to issue a license for the project, and if so what conditions to place on a license.

And next.

So I won't go too into depth, but here's a basic visualization of the timeline of our integrated licensing process. As you can see the pre-filing stage takes approximately three to four years, and the post-filing about one-and-a-half years. So from the initial proposal from the licensee to the -- the FERC authorization and license order is about a five-and-a-half year process.

Okay. Next.

One of the benefits of our licensing process is that it provides a forum to address the information needs of other agencies. So in utilizing our licensing process a licensee is also gathering information necessary to be compliant with other laws and regulations, such as Endangered Species Act, National Historic Preservation Act, and the Clean Water Act.

Okay.

So like I said, our NEPA document or environmental impact statement or environmental assessment document serves as the foundation for our licensing recommendations to the commission. Here's a sampling of typical environmental issues that we'll analyze in these NEPA documents, everything from fisheries and wildlife to water quality, cultural and archeological resources, aesthetics, recreation, and natural resources.

Next.

And we also analyze developmental issues, energy production, flood control, navigation, irrigation and water supply.

And that -- and that brings up a primary mandate of the commission. The Federal Power Act requires us to equally consider environmental resources and developmental resources in providing recommendations to the commission. Now it should be noted that equal consideration does not necessarily mean equal treatment, but it does mean that the developmental and environmental values must be given the same level of reflection and evaluation.

Okay. Next.

So like I mentioned, section 4(e) of the Federal Power Act requires equal consideration. So in balancing -- in balancing these considerations the commission looks at the relative value of the existing power generation, flood control and other developmental objectives in relation to non-developmental objectives, such as needs for improved water quality, recreation, fish, wildlife, and other aspects of environmental quality.

Next.

Some other considerations that come up in licensing, under section 10(j) of the Federal Power Act, FERC must include conditions to adequately and equitable predict, mitigate and enhance fish and wildlife and their habitats based upon the recommendations of federal and -- state and federal fish and wildlife agencies. We also take -- have to take into account any comprehensive plan that exists. And in cases where the proposed project would be located on a federal reservation the agency responsible for managing that land can file conditions to protect the reservation, and those conditions are required to be included in any license issued. So those are mandatory conditions that -- that we don't have any say over.

And similarly the secretaries of Energy and Commerce can provide (inaudible) that license projects.

Again, and those conditions are mandatory.

Okay. Next.

So in summary, just here's the basic conceptual pattern for a pathway to a license. It starts with the conceptual project development. An applicant provides us with a project proposal. Stakeholders, agencies and tribes all participate in the information collection, analysis and dissemination. A licensee produces an application. There's an evaluation period where both FERC and -- and the stakeholders I mentioned evaluate the application. And then finally the commission makes a decision which, like I said, can result in a license. And if -- if a license is a result, a condition is placed on that license.

Okay. Next.

So here are just some resources I'd like to provide. Our website, www.ferc.gov, includes our licensing web page. And it's a great overview of our licensing program. There's a summary of any issued licenses and permits. There's guidance. And we also have more information regarding pump storage on that website.

We have an e-library which is a searchable database of all the issuances and findings at the commission. If -- if you have a project you're specifically interested in you can e-subscribe to it and you'll be updated any time there's a new issuance related to the project.

We also have a form called e-filing where applicants and stakeholders can electronically file documents on a proceeding to us.

Okay. Next.

And again I'd just like to point out, these are our branch contacts by geography. Obviously, you'd be most interested in contacting the West Branch. Our Chief is Tim Konnert and his telephone number is listed there below for anyone that -- that has any further questions.

And last slide.

Well, we'd just like to thank you very much, and we'll hang back for any questions.

CHAIR WEISENMILLER: Yeah. Thanks for participating today.

Questions?

MR. BUHYOFF: My pleasure.

CHAIR WEISENMILLER: Yeah. I guess I'll give one to the PUC person for a second.

Given that you guys regulate rail safety, do you have anything to do with advanced rail energy storage permitting?

MR. BUHYOFF: No.

CHAIR WEISENMILLER: Can you think about that?

MR. BERBERICH: Not in my experience. I think this project is proposed to be in Nevada. So you should talk to another public utility commission.

COMMISSIONER PETERMAN: Just one thing in terms of an agency perspective. I know that the Energy Commission, at least through some of the EPIC work, may be doing some research that's relevant. And so I just want to make sure you can -- if you can bring to our attention anything we should be aware of that the CEC is doing in this space.

CHAIR WEISENMILLER: Sure. One which -- which Laurie ten Hope is doing a great job on is actually having meetings with your staff to talk about our research and make sure that -- and this was part of the EPIC decision was tying the research we're doing back to make sure those results are -- you know, can fit into -- when -- when they're useful that -- they're -- your staff are informed so that can fit into what you're doing in general, not just storage but across the board.

COMMISSIONER PETERMAN: That's great. I know you're doing some work on evaluation and methodologies for that. So we want to make sure we continue to work with you on that.

CHAIR WEISENMILLER: Oh, sure.

So thank you.

Let's go to --

MR. BARKER: So thanks to -- oh, go ahead.

CHAIR WEISENMILLER: I was going to say, I think we're now at public comment; right?

MR. BARKER: Yes. I just want to reiterate to folks in the room, if you do have comments, please see the Public Adviser in the back, fill out a blue card, and bring it up to me.

The -- and how we'll do this is for the folks participating via WebEx there's a raise hand button on there. We have only one participant currently with a raised hand. And so -- but we will start in the room first.

CHAIR WEISENMILLER: And I was going to ask the commenters, both in the room and online, to -- basically you've got three minutes to summarize stuff. Certainly we're looking forward to written comments. And you know, again, try to hit more of the high points. And I think most of you have heard a lot of the commentary from the speakers so far, so you don't necessarily need to repeat what we've heard from the speakers.

So let's start with -- yes?

MS. DIDLO: Good afternoon. Jennifer Didlo. I am the President AES Southland who owns three of the largest electricity generating facilities in Los Angeles and Orange County.

So just the one fact that I would like to contribute to the dialogue, since it is not clear to me exactly how we're describing bulk energy storage, AES is in the process, we have designed, we have gotten approved interconnection, and we are working on permitting 300 megawatts of battery energy storage in the parking lot at our AES Alamitos Facility in Long Beach. And I am here to tell you that that is completely scalable.

So I recognize that battery energy storage is specifically out of scope today, but I did want to let you all know, since it is a local permitting process, that we've got a 300 megawatt project teed up in the queue and it is scalable beyond belief.

So thank you.

CHAIR WEISENMILLER: That's great. Yeah. Yeah. I mean, this -- this one, we probably -- well, we could easily have spent the whole day on batteries. So the bottom line is we were trying to broaden the scope a little bit, broaden.

V. John White please.

MR. WHITE: Thank you, Mr. Chair, Members. John White from CERT.

On that last point maybe a distinction could be made between long-duration and short-duration storage as a factor, because I don't think it's technology specifically.

A very good workshop today. Thank you for convening it. A number of very high quality presentations.

Much food for thought.

I had a couple of process suggestions for how we might take a next step. The first is to recognize that we're not ready to do procurement, but we need to think about it. I very much agree with Mark Rothleder's comment that it's a vision that we have now with SB 350 of where we need to go. And if you work back from that vision rather than forward from where we are today, then the E3 modeling and some of the other work that NREL has done also suggest that if you look out far and you look at greenhouse gas the value of storage becomes more obvious.

So I think substantively what might be the next step is to borrow a page from our history when we had the Tehachapi wind resource. We knew we wanted to develop the wind resource but we didn't have a way of doing it that was a precedent. So they did a study group, the Tehachapi Study Group, where Edison was directed by the commission to come back to them after reviewing and studying the options. That led to the successful outcome.

So I think in this case what you could do is direct the utilities to spend some money evaluating the commercially identified projects, comparing their attributes, their costs and environmental issues, and then examine, as was mentioned, ownership options, whether it's rate base, whether it's joint ownership. I very much agree with the Chairman's observation about involving the public utilities. And also while we're doing it we might want to look at the existing hydro assets that we have on the system with Department of Water Resources and Bureau of Reclamation, LADWP which was touched on, and see how those assets can be perhaps better utilized to support the emerging needs that we have.

So thank you very much for your attention and thanks for having me here.

CHAIR WEISENMILLER: Thank you. I'm just going to follow up on history for a second.

In terms of multilateral agreements, obviously there's a number of them around the west that built various transmission lines or nuclear or coal plants. So again, it's certainly something that's not foreign to the utility DNA, most of the time into these come together projects and then do proposals to their appropriate rate-making agency, if it's -- some of them have certainly been combinations of POUs and IOUs. So -- but again, I don't remember in history how much foreshadowing they had from the -- from the regulatory bodies about welcome receptions (phonetic).

MR. BERBERICH: Chair Weisenmiller, I do think, to follow on your point there, that we're going to have to have multilateral agreements to do these. And I think that's probably where we'll have to put our efforts because that will be the challenge.

And the other, certainly it was touched on earlier, we want to make sure there aren't free riders because these are generally system-level resources as opposed to local resources. So we'll have to come to terms with that too.

CHAIR WEISENMILLER: Tony. Tony Braun

MR. BRAUN: Tony Braun, today on behalf of the California Municipal Utilities Association. I was prompted to come up and give brief comments today because of all the interesting testimony that we had.

You know, the Chair's remarks on the POU storage activities are probably correct and probably not surprising. I think a lot of parallels with AMI where, you know, if you add us all up together, including L.A. and SMUD, we don't even equal PG&E or Edison combined. And so it's easy to conceive how the larger utilities go first on some of these more groundbreaking activities, and the POUs come later. But at the same time we've seen widespread AMI disbursement in the POU community now. So I think that, you know, I think it's a natural progression.

The other thing that I think is a lesson out of this is perhaps what we went through with the FRACMU (phonetic) process where the ISO's first proposal had an approach which basically took the system ramping needs and spread them on a load ratio basis. And we would be able to empirically show the ISO that our portfolios didn't look like everyone else's portfolios when it came to the demands that we were placing on the grid. So I think it's really important to keep those type of cost allocation and price signal-type incentives in place for people to manager their -- the grid burdens that they're placing on the system.

And that, of course, gets to the cost allocation issue we've heard so much about today. I think the multilateral approach is tremendous. I mean, you see it throughout the West, whether it's the D.C. Tie, numerous generation plants, large hydro projects, they get built through the combined efforts of many, many entities, and I think that's right. I don't think it should be confused with enforced peanut buttering of costs or say, you know, those who benefit, or even a granular breakdown into single digit percentages in one instance. Not everyone contributes to the -- to the same demands on the system. And when you do that it blunts other efforts.

We have a large POU here that has some very aggressive demand shaping and customer programs that they're trying to use to manage. President Picker can speak to that in more detail than I. You wouldn't want to blunt that by saying you must also pay your share of a pumped storage facility. So everyone is going to come out with a lot of different results. And I think we should let, you know, several flowers bloom in that regard.

And at the end of the day it's an interconnected grid and everyone benefits, whether it's the water projects' hydro supporting the intertie ratings or whether it's a local municipal having a local capacity unit that keeps the lights on in the middle of Edison's area, that happens. And I think that shouldn't drive us to an end result where we're all sending each other bills to pay for each other's facilities.

CHAIR WEISENMILLER: Yeah. Thanks. Two comments.

One is obviously the POUs have a lower cost of capital than the IOUs, so you would think they'd be somewhat more inclined to do capital-intensive projects, other than the scale issue. I mean, as we were organizing this we were surprised when, obviously, you didn't SMUD at the table on proposed pumped storage projects, because it seems like that one is now gone off the list. So again, SMUD looks at a number of the options. We're sort of sorry that -- that they're not one of the pioneers in this area any longer.

MR. BRAUN: I'm not sure. I couldn't speak with personal knowledge on the status Iyo Hill. I see it on the FERC list. I don't think there has been a final decision on what to do with that project.

CHAIR WEISENMILLER: Thanks again.

Ed?

MR. CAZALET: Thank you. I'm from MegaWatt Storage Farms speaking for NGK Insulators. And Commission Peterman mentioned the sodium sulfur battery that she found out about on her trip to Japan. We'll submit some of the information she requested on the trajectory.

But Tokyo Electric, the world's largest private power company, back about 1980 was running out of effective and low cost storage sites. So they created -- they started their development of a battery system, the sodium sulfur battery. They put $1 billion and 20 years into it. And about 2000 they started to commercially deploy it. It's a 15-year battery with a 6-hour discharge, about an 8-hour charge. So it's the perfect size for, you know, integrating excess solar, for example.

And the key thing about any battery, but particularly this one, is you can deploy it in the size and the location and in the -- and when you want to. In fact, you can move it. So this is the most commercially deployed and proven battery around the world. There's about almost 4 gigawatt hours deployed around the world, about two-thirds of that is in Japan, it's in the Middle East, it's in Europe, 20 megawatts in the U.S., 6 megawatts -- 7 megawatts in California; 6 megawatts of that went through a study that was led by the CEC --

CHAIR WEISENMILLER: Yeah.

MR. CAZALET: -- CEC and so on.

CHAIR WEISENMILLER: Yeah. No. I was going to -- on that particular one you can see that Vaca-Dixon is the good news.

MR. CAZALET: Right.

CHAIR WEISENMILLER: The bad news is just before it was installed the warranty was eliminated because of an accident in Tokyo. So it's really an R&D activity.

MR. CAZALET: Well, I don't think the warranty was eliminated. They came in and repaired, made any necessary repairs for free for every battery in the world.

CHAIR WEISENMILLER: Well, they replaced them --

COMMISSIONER PETERMAN: I mean, if maybe --

CHAIR WEISENMILLER: -- just before they bolted out.

COMMISSIONER PETERMAN: That would be interesting maybe to get some information on. Because if I recall --

MR. CAZALET: Yeah.

COMMISSIONER PETERMAN: -- after that accident the company invested, as you said, like $1 billion or something, you know, really focused on --

MR. CAZALET: Right.

COMMISSIONER PETERMAN: -- trying to address that safety issue.

MR. CAZALET: Right.

COMMISSIONER PETERMAN: So they were very cognizant of that --

MR. CAZALET: Right.

COMMISSIONER PETERMAN: -- in trying to move forward.

MR. CAZALET: So with additional support from the Japanese government they're driving down the cost of that battery. And so now the target is 23,000 yen which turns out to be under $200 a kilowatt hour for that battery, which is very competitive with any pumped storage plant. And you don't have the scale problems, as you all understand.

COMMISSIONER PETERMAN: Right.

MR. CAZALET: They're currently completing the world's largest battery in Southern Japan for exactly this solar situation. And that -- that plant was built -- is being built in about six months. And so --

COMMISSIONER PETERMAN: Okay. Yeah. But I think to the --

CHAIR WEISENMILLER: Okay.

MR. CAZALET: Okay.

COMMISSIONER PETERMAN: -- to the Chairman's point, you know, the safety priority and the warranty issues will be key for us. So --

MR. CAZALET: Right.

COMMISSIONER PETERMAN: -- any more information we're provided on that would be helpful.

MR. CAZALET: We'll provide that and I think you'll find that satisfactory.

CHAIR WEISENMILLER: And certainly any information from PG&E and you on the performance of the two tests we've had in California would be good.

MR. CAZALET: I believe that's a public report --

CHAIR WEISENMILLER: Yeah.

MR. CAZALET: -- available from --

CHAIR WEISENMILLER: Yeah.

MR. CAZALET: -- from our agency.

CHAIR WEISENMILLER: The report is.

MR. CAZALET: Yes. Okay.

CHAIR WEISENMILLER: But in terms of progress after our report.

MR. CAZALET: Okay.

CHAIR WEISENMILLER: Thanks.

MR. CAZALET: Uh-huh.

COMMISSIONER PETERMAN: Just one quick question, is there another project that -- Catalina Island, is there something --

MR. CAZALET: Yes.

COMMISSIONER PETERMAN: Okay.

MR. CAZALET: Edison has a one megawatt plant that's been operating for several years on Catalina Island.

COMMISSIONER PETERMAN: Okay. Some information on that, as well, would be helpful.

MR. CAZALET: Sure.

COMMISSIONER PETERMAN: Thank you.

CHAIR WEISENMILLER: Okay. Nevada Hydro Company please.

PRESIDENT PICKER: Mr. Kates, I hate to interrupt, but I have to remind you that Nevada Hydro owes the Public Utilities Commission $500,000 for previous environmental work. And I think it behooves you to sit down and talk to our staff and reach an agreement on making us whole on that debt before we really consider any of your remarks today.

MR. KATES: (Off mike.) (Inaudible.)

PRESIDENT PICKER: Okay. Thank you.

MR. KATES: Am I done?

PRESIDENT PICKER: For me, you are.

MR. KATES: Well, I just wanted to say one thing to -- to the others then. We sold this project twice, once to Enron, once to Morgan Stanley. We're going to sell it again so we can pay our bill. And as we've heard today, the main issue for us is having a path forward where investors can see where the revenue is going to come from. So whatever we can do --

PRESIDENT PICKER: I think you're going to have a hard time --

MR. KATES: -- that would be good.

PRESIDENT PICKER: -- until you make us whole.

MR. KATES: Thank you.

CHAIR WEISENMILLER: Okay. Anyone else in the room?

MR. BARKER: No one else in the room. We have one speaker.

Jimmy Nelson, you're -- you have three minutes for comments.

MR. NELSON: Hello. Jimmy Nelson, Community of Concerned Scientists.

So I've heard a lot of discussion about storage providing the current set of ancillary services such as regulation and spin. And this, of course, makes a lot of sense and is a good direction to go. But I kind of wanted to bring to everyone's attention one or two more essential reliability services that aren't yet ancillary services in the ISO but that could be in the future. So they're not yet ancillary services so they're hard to monetize, but they become more important as we add more renewables onto the grid.

So what I'm talking about is primary frequency response sometimes known as governor response or inertia or synthetic inertia, and they relate to the short timescale balancing of the grid after a contingency, typically on the less than one-minute timescale. So storage really fits in here because storage has really fast ramp rates, so they might be able to move a lot of, you know, in the upward direction a lot of energy in one minute or less.

And the reason why we might care about them is if we don't get enough of these essentially reliability services from other sources it's possible that the ISO might need to keep some gas plants online to provide these services. And generation from those gas plants could cause a lot of renewable curtailments. They could end up defining how low the belly of the duck can go, how far you can get that net load down using solar.

So I've shown this dynamic in our modeling with PLEXOS. And I think some of Mark Rothleder's comments suggest that we might also see this dynamic in the 2016 LTPP modeling.

So we -- we commend -- UCS commends the ISO for -- for starting a stakeholder process to look at primary frequency response. But at least in phase one of this process we're focusing on getting more frequency response from conventional resources. And so it's unclear whether the capabilities of storage will be included or valued in phase one, which will go through the start of 2016. The ISO will look at a more diverse set of resources in phase two which will hopefully start in 2016.

So I think going forward it will be important for storage to be compensated, ideally through a market mechanism for their capabilities in the frequency response arena. And I think that can help potentially make some of these projects pencil out in terms of finances. So to this end, UCS encourages the creation of technology-neutral markets of the ISO for sub-one-minute contingency response.

Thank you for your time.

CHAIR WEISENMILLER: Thanks.

Anyone else on the line?

COMMISSIONER PETERMAN: Ask a question, given the comments just made by Mr. Nelson.

I'm just wondering, is this -- are these services that the ISO is currently looking at?

MR. NELSON: So --

COMMISSIONER PETERMAN: No.

MR. NELSON: -- the primary --

COMMISSIONER PETERMAN: I'm not -- Mr. Nelson, I'm going to ask the ISO, who's in the room. Thank you, though.

MR. NELSON: Oh.

MR. ROTHLEDER: Yeah. This is Mark Rothleder again.

Yeah, as Mr. Nelson indicated, we are currently in the process of investing frequency response and the potential product associated with that. And I think Mr. Nelson is correct, that there is a phase one because we have to meet our -- our compliance requirements at the end of 2016. And then subsequent to those is their further expansion in terms of the types of resources that can provide frequency response. I think we're very open to exploring the idea of a wide range of resource technology, including synthetic inertia, being able to provide that service capability.

So it's -- it's consistent with our objective is not to limit and be very open in terms of what can provide those services, as long as it is technologically meeting the frequency response, very short -- a short term service.

COMMISSIONER PETERMAN: Thank you.

MR. BERBERICH: Commission Peterman, if I might add also, I think Jimmy is -- Mr. Nelson is exactly correct that, you know, as we look to decarbonize the electric system, part of our challenge is to have the resources online to meet ramps, and a lot of that comes from conventional resources now. And storage will give us the opportunity to keep those off, which has the double effect of reducing over-generation as well.

So I think there's a lot of value in this space and we're certainly going to explore it.

MR. BARKER: So with no further comments, we turn it back to the dais for closing comments.

MR. BERBERICH: I guess I would -- I would like to thank everyone for participating today. I think this is the first of a long list of -- a long road of conversations that we need to have about this. Clearly as a -- as a grid operator, storage is a -- is a very flexible resource and can do all kinds of things for us, as we talked about here today.

What we also, though, want to mindful of are all the tradeoffs that we have as we go down this road, and particularly I think that John White said it very well, that we need to work from 2030 back, because that's only 15 years from now and we have a lot of things we're going to have to do. And I think storage is going to have to play in that role.

The question will be where does storage -- one, from a bulk perspective, how is it going to compare with other kinds of storage as those costs fall? And we're going to have to try to use a crystal ball, I think, to a degree to do that.

So with that I think this has been an excellent workshop, and we certainly appreciate everyone participating.

CHAIR WEISENMILLER: Yeah. Again, this is Bob

Weisenmiller.

I want to thank everyone for their participation. This is an issue. I guess the major idea was we wanted to get a chance to listen on this -- in this area. Certainly, that’s been sort of a common refrain, I think, in terms of, obviously, the more you dig into these things the more complicated it can get, you know, in terms of we’re obviously all trying to move more to looking at services as opposed to little silos of technologies. I think we’re trying to avoid having, here’s the storage silo and, oh, by the way, here’s the pumped storage part of that or the long/short or you know, what’s the portfolio?

So the more we can focus on what -- what services we’re trying to get to and what are the tradeoffs among things on how to provide those services, realizing that ultimately a lot of it is going to come back to the markets, you know, that as you put something out to bid, you know, you can see how this fits in with other pieces of it. And it seems like one of the unique challenges here is that economies of scale drive it to something larger that gets more of, you know, a multiparty aspect to it. So that -- that seems to be one of the regulatory challenges.

And again, because of the externalities, you know, it may well span across different entities. But as Tony said, people have different needs, although really we’re hoping that all the POUs really ramp up their renewables, well, they will, to 50 percent. So they may find themselves having similar needs as they go up the curve.

PRESIDENT PICKER: I'm also going to agree with Mark Rothleder's comments, but I'm going to -- I'm going to actually expand it a little bit. Because I think that the vision that we need to have is really aimed at figuring out what it is that customers need, what the system needs. And then -- then -- then and only then can we start to think about how these technologies are the least cost and best fit and the least greenhouse gas emitting for each of those occasions.

And so I think that that is a challenge because we've heretofore really either focused on providing energy or providing separately reliability, or more recently focusing on technologies individually across a whole range of different buckets of procurement without really starting to think about how they fit together to meet those critical system needs. So -- and I do think that that will be the challenge that SB 350 puts before us, emphasizing greenhouse gas reduction and least cost/best fit.

COMMISSIONER PETERMAN: Well, thanks. This was a very good workshop. Thank you to my colleagues on the dais for organizing it. It was an excellent agenda. I think all the presentations were useful. I look forward to doing a more careful read afterwards. And I also look forward to your comments.

You know, I support the comments made on the dais. I'll say that parties have been asking in the storage proceeding for the last couple years for a deeper discussion on bulk storage and long-duration storage. And there were reasons why we have not had it previously, but I think the timing is right now. And so I appreciate you bringing this forward.

I will note we've talked a lot about optimization which is key. But we know that, especially when we get out to 2050, we're going to need more of some resource, that we don't have enough of any resource that's low-carbon to actually meet our needs. And so it's going to be about both having procurement pathways to bring things on and optimizing.

And so I look forward to working with you more on this. I'll say these topics are very relevant, as well, to the discussion we're starting to have at the commission on integrated resource planning. And so I encourage you to attend or listen in to a discussion we're going to have on December 2nd about SB 350 with a particular focus on IEPR. Thank you.

MR. BARKER: One thing I just would reiterate, for comments for this workshop, they're due December 18th. So you have about a month, given the holidays, too. And remember, it's -- the Docket Number is 15-MISC-05.

CHAIR WEISENMILLER: Great. Thanks again. Thanks for your participation. And this meeting is adjourned.

(Whereupon, the Joint California Energy Commission and Public Utilities Commission Workshop adjourned at 2:41 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 7th day of December, 2015.

Kent Odell
CER**00548

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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

MARTHA L. NELSON, CERT**367

December 7, 2015