BEFORE THE
CALIFORNIA ENERGY COMMISSION

In the matter of,	)
	)Docket No.11-IEP-1N
	)
IEPR Committee Workshop on Energy	)
Storage for Renewable Integration	)

IEPR Committee Workshop
Energy Storage for Renewable Integration

CALIFORNIA ENERGY COMMISSION
HEARING ROOM A
1516 NINTH STREET
SACRAMENTO, CALIFORNIA

MONDAY, APRIL 28, 2011
9:30 A.M.

Reported by:
Kent Odell

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Byron Washom, UC San Diego
Michael Colvin, CPUC
Mark Rothleder, CAISO
Michael Kintner-Meyer, U.S. DOE

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PANEL 3

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Dan Watkins, LBNL, Demand Response Research Center
Lon House, Professor
Alfonso Baez, SCAQMD
Ed Stockton, Hydrogen Technologies, Inc.
Billy Powell, Local 684, Central Valley Elec. Workers
Bill Taylor, Central Valley Plumbers and Pipe Fitters
Harold Gottschall, Technology Insights, on behalf of NGK Insulators
Amber Riesenhuber, Independent Energy Producers Association
Craig Horne, EnerVault Corporation
R.J. Shims
Rick Winter, Primus Power
Stacey Reineccius, Light Sale Energy

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P R O C E E D I N G S

APRIL 28, 2011 9:36 A.M.

MS. KOROSEC: All right, if everyone can take your seats, we're going to go ahead and get started. Good morning, everyone, I'm Suzanne Korosec and I manage the Energy Commission's Integrated Energy Policy Report Unit.

Welcome to today's Workshop on Energy Storage for Renewable Integration. This workshop is being conducted by the Commission's Integrated Energy Policy Report Committee.

Before we get started, I just want to cover a few brief housekeeping items. For those of you who may not have been here before, there are restrooms out the double doors and to your left. There is a snack room where you can get coffee on the second floor of the atrium, at the top of the stairs, under the white awning. And if there is any kind of emergency and we need to evacuate the building, please follow the staff out the building to the park that's diagonal to the building and wait there until we're told that it's safe to return.

Today's workshop is being broadcast through our WebEx Conferencing system and parties need to be aware that we are recording the workshop. We will make an audio recording available on our website within a couple of days of the workshop, and we'll also make a written transcript available within about two weeks.

In terms of how today's topic fits within the 2011 Integrated Energy Policy Report, one of the Energy Commission's top priorities this year is to evaluate strategies and technologies that will support achievement of the goals in Governor Brown's Clean Energy Jobs Plan, which, among other things, include adding 20,000 megawatts of new renewable generating capacity in California and accelerating the development of energy storage.

The Governor's plan emphasizes that energy storage will help reduce the need for peaker plants and for imports from out-of-state coal plants, and will also help smooth out the variable renewable power such as wind and solar.

As part of the 2011 IEPR, the Energy Commission is developing a strategic plan for increasing renewable generation and transmission infrastructure in California. That document will discuss challenges to meeting the Governor's renewable energy goals and provide suggested strategies to address those challenges. As we're all well aware, energy storage is one of a suite of strategies that can support integrating high levels of renewables, while maintaining system reliability.

We're looking to all of you today to help us develop specific near-term, mid-term, and long-term strategies that will ensure that we have the amount of cost-effective energy storage that we'll need to support California's renewable energy goals, while maintaining system reliability.

We have a very full agenda today. This morning, we'll hear from several speakers from universities and State and Federal energy agencies, followed by a panel discussion on the need for energy storage to meet California's energy and environmental policy goals. We'll break for lunch around 12:30, depending on how the morning's discussions go, and then we'll reconvene after lunch with a panel on Energy Storage Applications and Economics, followed by our last panel on Utility Perspectives.

We'll round out the day with an opportunity for public comments. During the public comment period, we'll take comments first from those of you who are here in the room, followed by comments from those participating on WebEx. For those of you in the room who wish to speak, it's helpful if you can fill out a blue speaker card, which our System Public Advisor, Lynne back there has in her hands, and you can either give those to me or to Avtar Bining, who is our Staff Coordinator for this workshop. When it is time to speak, it is helpful if you can give the Court Reporter your business card and also come up to the center podium and use the microphone so that the WebEx participants can hear you.

For WebEx participants, you can either use the chat or raised hand functions to let the WebEx Coordinator know you have a question or comment, and we'll open your line at the appropriate time. For those participating only by phone and not through the WebEx system, we'll also open the lines at the very end of the public comment period to give you an opportunity to ask questions.

We are accepting written comments on today's topics until close of business May 11th, and the notice for today's workshop, which is available on the table in the foyer and also on our website explains the process for submitting comments to the IEPR docket. And with that, I'll turn it over to the dais for opening remarks.

CHAIRMAN WEISENMILLER: Good morning. Thank you for your participation today. This is the IEPR process. As Suzanne said, we're very focused on distributed gen this time, there will be a series of workshops. Today we're looking at the storage piece of the puzzle and certainly trying to develop a comprehensive record, certainly encourage people to have a full exchange in terms of the panelists as we go forward, and then also encourage people to give us thoughtful comments by the 11^{th}. So, thanks.

COMMISSIONER DOUGLAS: Good morning. I will join Chairman Weisenmiller in welcoming all of you to the Energy Commission IEPR Workshop, those of you in the room and those of you taking advantage of WebEx opportunities. We're really interested in hearing from you. Storage is a very important strategy as the state moves forward in its renewable energy and climate goals, so we're eager to hear and learn what we can from this workshop and afterwards from public comments.

MS. KOROSEC: All right, we'll go ahead and get started. We will start with Mike Gravely. He'll give us an overview of today's workshop.

MR. GRAVELY: Thank you. Mike Gravely from the Research and Development Division, and I'll be the Moderator for today's sessions. One of the things I want to point out for both the speakers and the audience is we have a very full agenda today, and so we're asking our speakers to state to the timeframe we've asked, and typically a six to eight-minute presentation, so we have time at the end for the dais to ask questions. We have a question and answer session in the morning and a question and answer session in the afternoon, if we stay on schedule, we'll be able to have sufficient time to do that, so I may end up having to pull the hook on some speakers and slow them down, if necessary.

All the presentations are available online, all the presentations are formal records that we can use and reference as we prepare the IEPR, and so, for that reason, we may have some presenters summarize their charts as opposed to covering every point on their chart; they can cover the key points.

In general, for those that aren't aware, we did have a workshop on November 16th, which was – this is the second in a two-phase effort on Energy Storage, and also on the use of Auto-DR as an alternative or a complement to energy storage. That workshop, it was mostly technology oriented, and the basic desire of that workshop was to understand the state of technology, understand the state of demonstrations, and understand the commercial state.

Today's workshop, we'll have some presentations from technology presenters and technology developers, but the primary focus today is one what are the barriers they're running into, what are the policies and procedures that would help accelerate their technology to be successful, in general. So, today's workshop is going to focus more on what the challenges are, how do we get storage more applied into to California, and then talk a little bit about what is the ultimate mixture we may need in the future for storage. Storage provides a valuable perspective for integration of renewables, but there may be alternative we have to consider. At the end of the day, the state needs to find the most cost-effective and efficient way of doing all this. So, we do have a very full room here and we have a large crowd on the Internet, so we'll do our best to keep up to speed and keep moving on.

So today's agenda, we'll start off with several presentations to help set the baseline for us. In the PIER Program, we have done quite a bit in storage throughout the years, and right now we have a couple major efforts that we are very enthusiastic about, one of them is developing a vision for energy storage. As most of you know, we've been doing visions for Smart Grid, and as part of Smart Grid, energy storage is part of all those packages, but energy storage has received so much attention in some of the questions we had, so we actually awarded the contract and you'll hear briefly about that in a little bit, to talk about what is a vision for energy storage for 2020, in addition to looking at renewable integration and other applications of energy storage that may help bring down the cost and improve the productivity of energy storage.

In the Panels today, we'll talk specifically about the needs for storage and the applications for storage, cost effectivity, and cost issues with storage, and wrap up the day with the utility perspective because, obviously, the primary focus today is utility level storage or storage to support utility level operations, whether that's transmission or distribution. We're looking at the integration of renewables as our primary challenge, and that's what the focus will be today.

And with that, I will start off with our first presenter, and Ethan will talk to us, and Byron, are you also going to speak? Yeah, so together you'll hear a little bit of where we stand on this vision for 2020. We encourage anybody here who is participating to contact these individuals. We're still in a draft form, they'll take your input, they have public meetings, and ultimately the results from their work will help us formulate our recommendations for the IEPR at the end of this year. Ultimately, today's workshop will provide us details that we need to come up with recommendations when it’s from the staff perspective, for recommendations and future suggestions on how to address storage for renewable integration. And with that, I’ll let Ethan and Byron come talk.

MR. ELKIND: Okay, good morning, my name is Ethan Elkind. I’m with the Center for Law, Energy and Environment at U.C. Berkeley, School of Law, and I also have an appointment with the Environmental Law Centers at UCLA School of Law, and I’m going to talk a bit about kind of an overview to set the table of some of the policy issues at stake when it comes to energy storage, and also talk about the Energy Storage Vision Project that Mike just referenced, and then I’ll hand over the baton to Byron Washom midway through.

So, our work on energy storage comes out of a workshop and a White Paper that we released from the two law schools at UCLA and UC Berkeley, and we gathered industry stakeholders and discussed some of the key barriers that they’re facing in relation to deploying more energy storage technologies along the grid. And they came up with some recommended policies, so we encapsulated those in the White Paper.

And first, when we talk about Energy Storage, we needed to define what we were talking about and this was an exercise that did not lead exactly to consensus, but we narrowed it down somewhat and came up with a definition, a physical system with the ability to capture energy for dispatch or for displacement of electricity use at a later time. And there is also a definition now enshrined in AB 2514, but we think this somewhat encapsulates energy storage as a starting point.

And we were looking at energy storage in part because of the effort to integrate 33 percent renewables by 2020, which is now in the law, and also because of the need to reduce peak load power and spinning reserves. And I suppose I would be remiss if I didn’t also mention that, you know, now, since we’ve done this workshop last year, we now have the Governor, Jerry Brown has his energy proposals as is referenced to have utilities shift five percent of their peak load power, and there is some data about the value of energy storage for other uses, as well. So, there is a strong need here and, of course, we have AB 2514 as a policy driver. I should also mention the general Grid operational support benefits that energy storage may be able to provide.

So, these participants focused on some of the key barriers, including regulations and utility processes and there are a number of layers to this, but

I think, when we talk about regulations, a lot of the common refrain that we heard was that we have a regulatory system that is designed to meet more conventional means of supplying energy and it doesn't necessarily favor, and in some cases would disfavor energy storage, which may be able to compete where the regulation is designed in a different way. They talked about monetizing the ratepayer utility and societal benefits and the challenges associated with this, so finding a way to monetize that value stream.

Another barrier that we have, issues regarding technological maturity and high capital costs, and particularly when you're faced with a situation where we cannot deploy the energy storage technologies at a large scale, you're not able to take advantage of the economies of scale to bring down capital costs.

And finally, they identified a lack of public awareness, and I think this workshop is obviously getting at this barrier, but a sense of what the benefits of energy storage could be, not just for grid operators and utilities, but also for ratepayers and the public. So, out of this discussion, some regulatory considerations came out and I should also mention that, even though I'm working on the Energy Storage Vision Project, this was from our separate study, so this does not necessarily reflect what we will have in our energy storage vision project, although I think we'll end up touching on most of these issues.

So, the first thing they talked about was the need for an energy storage asset class, a separate asset class to provide more certainty that energy storage costs can be reimbursed and provide more certainty in that respect, and I think if FERC were to take the lead on that, that that would have a trickledown effect for State policies. Also, for the CAISO to unbundle ancillary services, to provide energy storage technologies and manufacturers and developers to have an in, to be able to bid on some of these ancillary services.

Also discussed was adding energy storage to the loading order, which may not involve adding it as a standalone class, but perhaps adding aspects of energy storage throughout the energy loading order where it is appropriate. Having the CPUC establish a resource adequacy value to incentivize contracts with energy storage developers and, I think, a critical method, a critical aspect that I think is still very much needed is finding a method for energy storage value to be reimbursed to providers, so this would involve, at least at one level, developing a cost methodology analysis that everybody could agree upon. And then we also have to consider the implications of the 33 percent RPS and the integration efforts.

So, considerations to lower the cost, and so that was a critical barrier, continued R&D, tax credit incentives, I know there are some Federal discussions on this, and then CPUC standardized contracts for customer provided storage could help streamline processes and put more certainty into the process. Rate basing substation and utility scale storage systems was also discussed and encouraging large quantity long term commitments to help bring down the costs of the economies of scale.

So, having said all that, it is somewhat of a quick overview of some of the policy issues at stake when we talk about energy storage.

I want to talk now about the Energy Storage Vision Project. This is a project sponsored by this agency and the PIER Program, and the research team involves the California Institute for Energy and the Environment, my school, the University of California, Berkeley School of Law, researchers at the University of California, Los Angeles, and University of California, San Diego, and Byron will be representing them. We have a diverse advisory committee. We're trying to make this process as open as possible to get input from all the key stakeholders. We don't want to be in the business of surprising anyone when they click open that PDF that eventually will be available for folks, so here is a list of just some of the people we have on the Advisory Committee, and we've been in regular contact with them and continue to look forward to getting input from them.

The project involves two parts, so the first part is to do a technical status review of the various energy storage technologies and identify the remaining research and development needs. And then the second part is an effort to set forth a strategic vision for different energy storage scenarios over the next 10 years. And our goal is to highlight the value of energy storage to meet future state energy goals.

To give a sense of the project timeline and what our goals are, we are charged with supporting the CPUC in their AB 2514 process as they are going through their process of determining whether or not they will be setting targets for energy storage procurement and, if so, what those targets might look like. We also want to provide input as we're doing hopefully today to this IEPR process, and we also want to gather input from our Advisory Committee members, utilities, energy storage system manufacturers, etc.

We will have findings by almost next month, now, but it will likely be at the end of June, and then our final report will come sometime later this summer. And now I'm going to pass the baton over to my colleague, Byron Washom.

MR. WASHOM: Thank you, Ethan. I'm Byron Washom, Director of Strategic Energy Initiatives at U.C. San Diego. And I would like to first of all mention that, on our technical survey that we're doing, there is actually, for as young of an industry as this is, and technology, there is an excellent base of vetted publications. Unfortunately, with vetted publications, they tend to be lagging by the time it takes them to get to publications. So, we are depending a lot of our information on these publications, but we are also turning our attention to currently either publicly disclosed energy storage contracts, and that's for the first time is where you see the evidence of a willing buyer and a willing seller at a price, technical specs, warranties, etc. We're also getting access to some private contracts that also will provide us a much superior base than just the vetted publications.

R&D is an essential part of just about every aspect of the different energy storage technologies, and we are looking to, as a previous slide indicated, to deploy at the speed of value. And the speed of value is something that is technologically feasible, as well as cost effective. So, we are looking to analyze the feasibility of the forecasted -- or the AB 2514 schedule, as well as accelerating it beyond those schedules.

So, in analyzing the State and Federal policies, this is a policy driven market at the present time, rather than a value driven market. And it will be imperative that both Federal and State policies, including FERC, are involved. We will be looking outside the domain of the Federal and California policies for other potential applications, including Europe that might be relevant to us. And from this bouquet of policies, we will actually be identifying the most critical policies that our state here, as well as possibly the Feds, should be looking at.

We will be evaluating the scenarios for potential CPUC targets under AB 2514, which is probably the most contentious issue within 2514, and then we will be pulling three to five promising applications for energy storage likely to have either grid problems or grid opportunities in 2020. Those three to five candidates have not yet been identified and might be finalized as soon as lunch today, but they are in the areas of Area and Frequency Regulation, Renewable Grid

Integration, T&D Deferral, Load Following, and Electric Energy Time Shifting. So, I think that will be much the heart of our report, as well as our policy recommendations. And then, in terms of the scenario planning, it will be a business as usual which, on the present course would be long and slow, as compared to an accelerated deployment in which you would either have a technology push or a market pull in order to bring more opportunities in the value added of energy storage to the marketplace.

But we are reminded that there are potentials for disruptive events, both positive and negative, and we are seeing them occur almost daily, one disruptive event occurred with the earthquakes in Japan, which showed the lack of energy storage on-site at nuclear power plants; two weeks later, there is a U.S. Senate Hearing identifying that a vast majority of U.S. nuclear power plants lack the commensurate amount of storage, and suddenly we saw an overnight surge in demand for that type of storage in the marketplace.

We also are seeing, the smarter the Grid gets, maybe the less storage is needed, so there are disruptive events, and one has to be nimble in this Vision document to anticipate these disruptive events.

And then there are ongoing research needs. We are heartened by the issuance of a number of funding opportunity announcements from Department of Energy, ARPA-E, which is a major program that is not looking for an order of magnitude improvement in either the cost or the performance, and so ARPA-E is now attending to themselves not only to – DOE is attending themselves to the present technology, but ARPA-E is attending themselves to the over-the-horizon.

So we have had a number of different milestones of events that have involved primarily the public, as well as interested stakeholders, and we'll continue to be able to have this interface during the course of the summertime. And we have completed the technical surveys of the, if you will, the background document of the technically available technologies, as we see today, which gives us the framework for the deployment and the analysis.

So, as Ethan mentioned before, we're a multi-campus collaborative effort between Berkeley, UCLA and UC San Diego, and we're being led by the California Institute of Energy and Environment, and I'm showing now the contact information for all of us; all of us are equally accessible, and we would welcome your questions, inputs, comments, and criticism. Thank you.

CHAIRMAN WEISENMILLER: Okay, thank you. A couple questions. I guess I will start with a couple observations. First is, I think generally in the industry, the understanding is that, in terms of potential game changers in the electric industry, storage could be one of those, and certainly change the whole nature of things, so that's one of the reasons why we're really focusing on things today. The other general observation is, obviously the Governor is fairly clear that 33 percent is to be seen as a floor, not a ceiling, on the level of renewables we're shooting for.

In terms of turning more to questions, I guess the first question is that fundamentally with storage, do we need now economies of scale or market pull-through, or do we really need technology breakthroughs? You know, what does it really take to make this work?

MR. WASHOM: I would respond in this fashion. The subject of storage is like having a quiver to which you have a number of different arrows, which are a variety of different technologies. And so, appreciating how many different types of arrows you have in your quiver must be taken into account. Some arrows are ready to fly today, other arrows are not. And so, I personally am of the belief that "the volume cures all" is a myth, it's just not a matter of creating more volume. As I indicated earlier, deploying at the speed of value. So, where we need technology improvements, we need R&D first, and then move it into the marketplace. All the technologies in one form or another, due to their capital intensiveness, will probably need incentives of some type by the failure of the current marketplace to monetize the true value of storage. Storage has over 30 different elements of value and, right now, very few of those elements of value are monetized in the marketplace.

CHAIRMAN WEISENMILLER: Okay, well, that gets to the next question. If you think of Alfred Kahn’s basic definition of what is a utility function, it’s one where there are economies of scale. Obviously in the generation sector, that logic went away decades ago; the question is, in storage, is there going to be economies of scale? I realize there is a range of services here, is this going to be a utility function or a competitive function?

I would believe it will be a competitive function and there will be a role for the utility, particularly in the areas of large baseload shifting of load, as well as the issues of reliability, T&D deferral is primarily utility function, so there is a variety – again, out of this list of 30, some are very clearly long on the customer side of the meter, some belong on the utility side of the meter, and some afford themselves to the energy service providers.

CHAIRMAN WEISENMILLER: Okay, but, again, is that philosophy? Or is that economies of scale driven?

MR. WASHOM: No, I don't think – I think with energy storage, it's not economies of scale, it's location and value and the service that you're providing at a moment in time.

CHAIRMAN WEISENMILLER: Maybe, but, again, I think all of us can profit by listening to Alfred Khan on that issue, you know, I think certainly I remember in the last decade some theories of like unbundling some of the billing and metering services, and, again, that sort of flew straight in the face of economies of scale.

So, the next question is, you're talking a lot about storage, but what about complementary products like demand response? You know, what is the right mix? I mean, it doesn't seem like we want to do all storage at that cost, as opposed to some portfolio of responses that are storage, demand response, and presumably gas plants.

MR. WASHOM: I concur with that point of view. In the particular case, and I gave it a one-sentence treatment in my presentation of saying "the smarter the Grid becomes, the less storage that is required," demand response, automatic demand response, greater sensing, greater efficiencies in the marketplace of re-optimization and rescheduling of supply and demand, that all comes into play. And so there's actually a rivalry and intramurals, if you will, between storage and the smart grid. But ultimately, storage does definitely have a niche and the question is how large is that niche, and is the smart grid and Auto-DR eating away, eroding at the bandwidth of that marketplace?

CHAIRMAN WEISENMILLER: Okay. The next question, more specifically, you talk about the CAISO unbundling ancillary services, have you guys reviewed the CAISO tariff, at least for the battery storage approach?

MR. WASHOM: I personally am conversant in that, but have we as a group, I believe that is on our agenda to look at the CAISO activity. But I have to be careful with my pronouns of "we" and "I" today, so I think the "we" answer is we're about to do that. Thank you.

CHAIRMAN WEISENMILLER: Okay, and I guess my follow-up question was, that was designed to deal with the specific decay characteristics of batteries; will we need tariffs for each of the storage technologies to reflect their characteristics, or what?

MR. WASHOM: Actually, I would reverse that, in all due respect. And I would say the applications will be the ones that should be tariff-focused, and you allow the marketplace and the technologies to decide whether or not they can compete or not compete in the application. And what I'm personally finding, on Friday I'm opening bids for one megawatt of four megawatt hours on campus, and what I am finding is that the previous assumptions of where these technologies could or could not compete are actually changing. They're morphing. And so, the marketplace that's represented by your audience here is actually finding that their technology can go in and compete in applications we presently did not presume. So, I would say, be applications oriented on how you monetize the value, and then let the marketplace, and then technologists and the OEMs come in and try to penetrate those opportunities.

CHAIRMAN WEISENMILLER: Certainly, it's a lot better if we can design the services, reflect those in the tariffs, and then if people compete to provide those, in a way that provides the best value to the ratepayers.

MR. WASHOM: I concur.

CHAIRMAN WEISENMILLER: Okay, next speaker.

MR. WASHOM: Okay, thank you very much.

MR. GRAVELY: So the next three speakers will give us a perspective from the Public Utilities Commission, the ISO, and the Federal Department of Energy perspective. And Michael Colvin is here to give us – one thing we mentioned, besides the IEPR, of course, is 2514, and the research we're doing, the work we're doing also will feed into that, and we're very actively with the PUC in helping them, as well as the utilities are, so this will give you an overview and feel free to ask questions later about how the PUC sees 2514 flowing out.

MR. COLVIN: Good morning, Commissioners and good morning everyone else. My name is Michael Colvin and I'm a staff person on the Policy and Planning Division at the CPUC, and I am right now the staff lead on our energy storage efforts. It's a privilege to be here this morning.

Probably the standard stock disclaimer you always hear from staff people at these IEPR workshops is that, since this is a rulemaking, and we are actively trying to develop rules, not a lot of official PUC positions are being presented today, that a lot of this you'll kind of hear me weave in opinion and, kind of, facts. And I'll try to be really clear when I'm doing what. I also think it's worth noting that I'm right now also kind of wearing two hats at the PUC. I'm also acting as interim energy advisor to Commissioner Ferron, who is in charge of all of our renewable efforts, and so I’m not representing his views on any of our renewable efforts, so I’m kind of playing the staff role today. So, if I act schizophrenic, now you know why.

A couple of basics, I know most people in the room already know this, but just in case, AB 2514, the Skinner Bill requires the PUC by March of 2012 to open a proceeding to start looking at doing a rulemaking. We actually launched this already in December of last year, so we’re ahead of schedule, just to give you a sense of where we’re at in the timing. But the law asks us to determine any appropriate targets of all the load serving entities to procure viable and cost-effective energy storage systems. And then it asks us, by October 2013, essentially a year and a half later, to establish those targets if we find that any of them were appropriate. And it also said, well, make certain that, since this is a nascent market, to establish some clear milestones for 2015, so, a year and a half later after that, and then for 2020. So, those were sort of the timeframes of what can we do near term and what are we doing by 2020.

The law also speaks about some of the very similar milestones and approaches for the non-investor owned utilities in the state, but I'm not going to cover that part of 2514.

The policy goals of 2514 are fairly clearly laid out and say an energy storage system, if we're going to set some targets for this, it must be cost effective and it should also try and do one of the following things, and that runs the gambit from reducing greenhouse gas emissions or reducing peak demand, defer substitute investment and generation or transmission assets, improve reliable grid operations, and there's probably half a dozen other good policy goals that are within that, that the law doesn't specifically enumerate, but we need to look at and try to consider.

I'd like to point out for the purpose of today's workshop that the theme is renewable integration and, while critically important, at least in my opinion, it's not the only policy driver that we need to be focused on, and so there is a little bit of a balance of, "Yes, 33 percent is the floor, we are going to be moving towards more and more renewable integration, storage might be able to play a role there. But storage might also be able to play a role in a bunch of other places on our rapidly changing Grid, let's just not get tunnel vision." And so I hit on cost-effectiveness that was sort of the one thing that storage must be cost-effective and…. And so, the PUC can consider a variety of possible policies to encourage cost-effective storage to be deployed to the grid, it could be anything from refining how we currently procure assets to considering different contract methods, to different ownership models, to leveraging our self generation incentive program, anything and everything that is kind of within our arsenal. Now, I'll be clear that we're a ratemaking agency first and foremost, so when you have the hammer of ratemaking, we tend to look at things through rates or through contracts, and I think it's critically important that the Energy Commission – that we always work together because you guys have such a different perspective, and I think the two together provide the right chorus.

The trick, and this is kind of the classic policy trick, but the trick with storage of where we're at right now is costs are immediate and known, but the benefits are long-term and diffuse, it's kind of the classic policy problem and we need to figure out a way of determining what are the externalities, what are – how do we start getting the value of storage? And so I kind of put down there the key question I think we all need to figure out, whether it's at the PUC's proceeding, or everywhere else's: how do we properly enumerate the value of storage on our system?

Just to give you a couple of highlights of some of the major activities that the PUC has done, in July of 2010, sort of as the Skinner Bill was being developed, we put out a PUC White Paper, some of the contributors of that White Paper are actually in the room today, to say “here are what we identify as some of the barriers and opportunities for storage,” and coupled with the 2514 Bill, the PUC launched our rulemaking in December of 2010. For those of you who like numbers, our official Rulemaking number is R10-12-007, “10” for 2010, “12 for December, and “007” just because. Following the launch of the White Paper and of our rulemaking efforts, we asked parties to get some comments to say, “Well, what do we think the scope is of this, of what we should be looking at?” And, actually, and kind of an unusual step to really try and make certain we were getting full stakeholder input at the beginning of this process, we held kind of an informal pre-workshop to say, you know, make certain we are getting into everything, it was an extraordinarily useful event. Again, a lot of the people in the room were able to participate in that and it was critically helpful. About a week and a half ago, we hosted a pre-hearing conference mixer in that we were determining the scope and the schedule correctly. In our Scoping Memo, which will set the schedule, will be coming out probably in the next two weeks, so early May.

Getting into a little bit more of the substance, and I'm going to bifurcate a little bit of this into this talk now and then I'm on another panel later on today, so some of the stuff will be saved for that. But some of the key questions we need to consider is, "Well, what is the current status of the storage market?" And given the fact that there's both rapid technological change and, frankly, rapid market change, how do we create a general policy framework that will be sufficient? And what is the umbrella policy statement that we need to be making that can then be applied onto the various unique situations that we need? And I think one of the questions that I keep asking myself is, what are we trying to accomplish from an increased penetration of storage? What is the ultimate goal? You know, is it more for more sake, or is it more in order to be able to do this? Is it a means to an end, or is it an actual – the goal is just more?

You're going to probably hear this buzz word a lot today, but I'm going to be the first person to try and introduce it, what are the primary [quote unquote] "applications of storage?" Where does it make sense to actually be putting storage on our system? I think, hopefully, this talk and also some of the other talks in the first part of the morning will get at, are there unique market or regulatory barriers to storage? It is kind of the new technology, it is sort of a changing grid and a changing everything else, and so do we need to be thinking about some of our market rules, our contracting rules, etc.? And then, we probably need to do that across all the relevant agencies, and that will probably be one of our first efforts at the PUC is to just say, "Is there something that is just a market rule that can be changed immediately before we get into general policy-making, then, that just sort of needs to get coordinated?"

And then, this is again something that I use, a sort of a touchstone in thinking about storage, but how does storage connect to the other resources in the Energy Action Plan? And again, it goes a little bit back to this idea of applications, but if you think about storage and demand response, and the problems or opportunities there vs. storage and distributed generation that's behind the Grid, totally different barriers to entry, probably – different ownership models, different value streams, but yet it's all still storage. And so, just going through the rigor or going through the exercise of connecting to different points along the loading order is probably a useful way to making certain that whatever general policy framework we come up with is strong enough to go through that process, go through that ladder. And, again, sort of a sneak preview of some of the ways of how we're thinking about this, at least at the staff level.

The balance as we go forward needs to be, "What are the ratepayers trying to get for more – increased - amount of storage?" Cost-effectiveness, integration with the Grid, with either renewable resources, or what I would call non-dispatchable resources, things where we don't have control over how the Grid works, so we have a bunch of 24/7 must take resources on our Grid, in addition to the intermittence. And that sort of gets lost in the renewable integration conversation, but both, I think, need to – can be balanced by storage and can play that role. And ultimately, we need to balance kind of those different factors to be able to then send a clear signal out to the market to say, "Here's what we're trying to provide the opportunities for, now market it and see if you can run."

I'm going to have a couple other things for later on today, but I think this hopefully gives you a sense of some of the general policy thinking of where we're at.

My last thing, just to kind of say more to the folks in the audience is, if you're not used to participating in the PUC's process, please feel free to see me after or during one of our breaks, I can get you any information you need in terms of getting onto our service list or anything else, it's a big tent, we welcome public participation, especially in kind of a new topic like this, you know, the more voices the merrier. So, if you are kind of interested in anything I've had to say and want to learn more, please do participate. And with that, if you have any questions, let me know.

CHAIRMAN WEISENMILLER: Yeah, first, I want to really thank you for your participation today. I mean, obviously, we like to look at the IEPR as a opportunity for the State's Regulators, the Energy Commission, the PUC, and to some extent the CAISO, to jointly address these issues and certainly welcome your office's participation as we go forward, wearing your Commissioner Ferron hat in this activity, and I know he and I had talked earlier, unfortunately, and I understand his scheduling constraint, or else he might have been sitting at the dais today with us. I guess, you know, as you indicated, the PUC is very focused on rates and the cost of stuff; here, we’re probably more focused on the environmental impacts, CAISO more on reliability aspects, so we have to get all three to fit together. But, I mean, looking at your slide and looking at cost-effectiveness, the one policy issue we’ve struggled with, in our Building Standards, we have to look at lifecycle costs, so, again, cost-effectiveness. But in our most recent one, we’re looking at including greenhouse gas implications as part of the economics. I don’t know if the PUC has struggled with that question?

MR. COLVIN: Oh, mightily so. And, again, the question -- I’m going to shift actually to this slide here, you notice kind of the first bullet point is greenhouse gas emissions is sort of one of the key policy drivers that’s there, I think there are two answers to your question, one is eventually with AB 32, and if we get cap-and-trade actually launched, there should be a strong enough carbon market that hopefully will eventually translate into rates and for certain aspects of the storage market, a proper rate signal and a proper rate design is really critical in order to make the value chain actually work. And so, in terms of greenhouse gas emissions, this is talking about reducing greenhouse gas emissions, when I talk about rates it’s more about, well, what about the things that are actually being emitted? What's the value there? So I think that's kind of the first part of your question. The second part, which is a little bit less obvious to try and figure out in terms of the value chain is, what is the value of the avoided GHG, is it exactly equal to the carbon market? Maybe, maybe not. And in terms of, well, how do we make smarter procurement choices in terms of avoiding that next greenhouse gas, it's the mixture of markets and mandates that the state is pursuing here, and I think that goes back to the original kind of purpose of today's topic, which was renewable integration, and you know, no sources of power, and if storage can help promulgate more null sources of power, that might be something that needs to get palliative and I think that is going to be a hat trick we're going to have to figure out during this process.

CHAIRMAN WEISENMILLER: Okay. The next question is, as I said, to some extent storage and demand response are complementary, so, in the PUC context, are you considering the tradeoff between, say, more storage or more demand response?

MR. COLVIN: I'm pausing for a second because we do have some storage applications that are actually coming in as part of our demand response suite of applications, things like permanent load shifting.

CHAIRMAN WEISENMILLER: Right.

MR. COLVIN: And so I actually don't think that they are necessarily competing, I think that they actually can, sort of like the Venn diagram that they actually can overlap to a certain extent. In my mind, if we can come up with a proper value chain for storage to say, "Here's what we think storage stacks up correctly," then let's give choices out to the end consumers and say, "If you want to participate in demand response, here's that price signal, and if you want to participate in storage, here's this price signal." And there will probably be a little bit of turning left, but, you know, having your foot on the gas and the brake at the same time kind of metaphor, but at the same time I think that's what economists call "equilibrium," and that's a good thing. So, I don't think there's a direct competition there, I do think that demand response is a little bit more of a mature market, and so we might be looking at things from that lens a teensy bit more right now.

CHAIRMAN WEISENMILLER: Okay, and in terms of, as you talk about looking at moving forward, do you anticipate looking at the value or cost as you're setting rates or tariffs for, say, storage?

MR. COLVIN: I think both, in all honesty.

CHAIRMAN WEISENMILLER: I see, yeah.

MR. COLVIN: Not to completely evade your questions. But I guess I define value as what’s the value that could be positive or negative attached to it.

CHAIRMAN WEISENMILLER: Right.

MR. COLVIN: And then translating that into rates, as appropriate.

CHAIRMAN WEISENMILLER: Right. Yeah, and so I’ll try again, I mean, obviously you talked about, say, eventually the avoided cost of storage, and if you look at, say, generation historically, you know, if you go back decades and decades ago, it was all cost-based.

MR. COLVIN: Uh huh.

CHAIRMAN WEISENMILLER: And, certainly in the PURPA context, it became more value based. And so, again, and that was one way of introducing innovation into the generation sector. So, in terms of this innovation of storage, again, you could do it either by an avoided cost approach, or a cost-based approach. Or both, depending on applications or values.

MR. COLVIN: Yeah, now you’re making me want to put on another hat because I did PURPA and Q.F. and CHP stuff for two years.

CHAIRMAN WEISENMILLER: Well, good. So you know the problems of both of those.

MR. COLVIN: I do know the problem. I think it’s a perfectly valid question to ask and I don’t have – I think that’s something that I would kick out to the parties and say, “What should we be doing with this?” And hopefully it will develop, but I don’t have a gut reaction for you right now.

CHAIRMAN WEISENMILLER: That’s good because obviously, as you know, with the industries, depending upon the relationship between cost and value, they look to the Commission for either cost-based rates or value-based rates.

MR. COLVIN: Right, yeah.

COMMISSIONER DOUGLAS: I don’t have any additional questions. I really appreciate you being here and it was helpful hearing the exchange with Chairman Weisenmiller and your answers, so thank you. We’ll look forward to seeing you later on the panel.

MR. COLVIN: Yeah, thank you so much for all of your time.

CHAIRMAN WEISENMILLER: Thanks again.

MR. GRAVELY: The next speaker will come and address for us the California ISO perspective on storage, and I would add one additional question here for you to think about as you're here, and that is that we hear a lot of questions, in general, on our presentations here about what the rest of the ISOs are doing around the country. So, maybe at some time you can summarize where you think California's approach is compared to the rest of the country, if you don't mind. Thank you.

MR. ROTHLEDER: Thank you. I'm Mark Rothleder, Director of Market Analysis and Development with the California ISO. I'm also responsible for performing the Renewable Integration Studies; this is the non-transmission-related studies, so I'll be discussing that today.

The renewable integration effort, the ISO is very committed to California achieving its objectives for renewable policy objectives. We also have the obligation to, as Grid Operators, to ensure that the ISO and the Grid can be operated reliably as we transmission the resources mix to meet the load. The ISO has performed and is currently performing some additional 33 percent renewable studies, these studies are in coordination and in support of the CPUC Long Term Planning process, and they are looking out at what the operational requirements are in the 2020 timeframe, and also identifying if there's any residual needs that are not met by the expected resource mix that is planned. These studies are bounding studies, they are not definitive, they are highly dependent on the assumptions that you put into them, and I will be getting into a little bit of that in the subsequent slide.

What are the operational challenges? They vary and these three pictures kind of describe it best. The first is with load, itself, and then the overlaying with renewable resources, wind and solar. You have increased amount of variability and uncertainty, variability as cloud comes over, you've got a reduction of production; uncertainty is that it's hard to predict exactly what the level of production on some of the renewable resources are going to be. Both of those create a balancing challenge. In addition to that, there's dispatchability and over-generation, so while you can predict conditions, you may get into situations where the production of wind and all the rest of the resources exceeds what the load is at the time, and then you have a balancing issue, in which case you need some downward dispatchable capability and also, sometimes, upward dispatchable capability.

And then, in addition to that, there is just a different pattern that will start to arise in the future where we're very used to having the load pattern as the day starts, the load ramp comes in, and then in the evening the load ramp falls back off. However, with the offsetting amount of wind and solar, we do expect to have larger net ramps of balancing of the systems. So, we expect that the load itself, the load ramps, will actually be exceeded at times as the sun goes down and the solar goes down, and he wind starts to rise. There could be larger in-ramps and out-ramps that are needed to be balanced.

From our perspective of the studies, the studies are really multi-stepped. And the first step is to determine the operational requirements, and that is to quantify the amount of what we call regulation and load following service that are needed to offset the amount of variability and uncertainty in the system. After we come up with these operational requirements, we then perform production simulations that attempt to simultaneously meet both the energy and the required regulation and load following remaining reserve capability, as well as meeting spinning reserve operational requirements. And those production simulations are performed over an 87 60-hour year long period and they would identify, 1) any limitations or shortfalls in meeting any of those requirements. In addition, they provide some insight into the production costs and emissions necessary to meet those operational requirements.

Lastly, our studies do look at the inventory of the fleet of the system to assess what's happening to the flexibility of the fleet, is it going down? Is it changing? And how is it changing the capability?

These are some additional observations from the most recent study work, and this study work is preliminary right now, it's just starting to complete, and in fact tomorrow some additional information about the results will be published in support of, again, the CPUC Long Term Procurement process.

The new cases that are being run are different from last year's cases where we tried to attempt to study 33 percent. The assumptions for load have been modified in these new scenarios to reflect that there is about 7,000 megawatts of energy efficiency. Assuming California meets the objectives of the demand response and energy efficiency, what we're finding in the new cases, which is different from the previous results, is that the load following requirements have, 1) been reduced, secondly, the amount of residual need for regulation and load following services has actually decreased, in fact, we see little or no violations of meeting the upward capability. We do still see some downward shortages in the range of 1,100 megawatts.

How do we meet these shortages is something that really needs to be considered carefully because, if you're dealing with load following down requirements, it's probably not necessary to consider additional conventional resources, but it does set the stage for things like demand response, or storage devices, and curtailment of resources, the renewable resources themselves, assuming it's a fairly limited number of hours of violations.

Now, shifting to the storage technology and what role the different technologies play in meeting the reliability and operational objectives. And there's several different tools and different timeframes, and depending on the timeframes of these technologies, how long they can produce, how quickly they can produce, and how fast they can ramp. They play different roles in terms of meeting the reliability objectives, so, for example, batteries and flywheels, which may be able to act in very short periods of time, may be very appropriate for things that are voltage control, or direct like regulation balancing; things that have longer storage life and production capability are maybe suited for meeting the load, or shifting the load needs, over the day period.

And we realize that the evolution of these technologies is changing, so it’s not – while this graphic represents certain categories, certainly there’s crossover categories; in other words, maybe pumped storage that in the future has some ability to vary in pumping mode, may be able to provide some services in the regulation arena, or in the 10-minute balancing market. All these come into play in terms of meeting intermittent and energy smoothing, addressing ramping, and addressing over-generation conditions.

In terms of efforts underway at the California ISO, over the last year or two, the ISO has taken several steps in trying to remove barriers in terms of its market to allow for more non-generation resources to participate in the market. Some of these efforts, for example, regulation energy management, provides additional capability to allow resources to provide regulation, recognizing that some storage devices would not be able to deliver over a one hour period, but certainly can provide the service over a 15-minute period.

Other initiatives underway have been completed and change the make-up of the minimum size of the resource, we reduce that from one megawatt to 500 kilowatt, in order to participate in the ISO’s market.

In addition, we've, in the ISO and in working with the CEC, we're trying to modify the definition of regulation, spinning and non-spinning, to allow from a timing perspective storage devices to participate and provide these services.

The Regulation Energy Management System is one of the most recent initiatives and, really, this allows us to both use the resources for regulation purposes, and it's important, it's a technological effort to try to control when you charge the storage back up, when do you release the energy, and how do you do that in conjunction with the market and the underlying system balancing. And managing all that together does create some new challenges and does create some innovation in terms of how we control and our underlying controls and market systems.

Overall, the ISO is trying to support renewable integration, several efforts, one is the studies, in addition we're performing enhancements to forecasting tools, trying to come up with measures to address over-generation, and increased and better monitoring systems. For resources that are outside the balancing authority area, we're trying to come up with measures to allow for more intra-hour scheduling and dynamic transfers of renewable resources. And on the market side, we are addressing and trying to remove barriers and develop new market products that allow resources like storage to monetize and extract their value in meeting the operational needs. Some of the new market product developments will likely address and probably introduce new ramping products necessary to balance the system, and those will provide potential for capacity payments. The ISO is also interested in looking at, longer term, and any kind of capacity market or through resource adequacy, how can storage devices participate and meet those requirements.

Lastly, the tools that we have will require additional enhancements to incorporate any of these resources in managing renewable integration, and we’re committed to modifying and adjusting these algorithms to optimize the use of the system. Thank you for the opportunity and I can take any questions at this time.

CHAIRMAN WEISENMILLER: I’d first like to thank you for your appearance today. I think, certainly, we appreciate the opportunity to work with the CAISO and to be able to get the benefit of your operational experience in this type of context. So, a couple questions. The first one was just on – it seems like the whole operational stuff, I’ll go through three scenarios and we could talk about how storage fits in those scenarios. The first event is responding as an operator to sudden drops or increases in, say, wind output. I know when I was at the CAISO building dedication, I think one of the things Steve said was that, you know, in the last couple of weeks, you’ve had a drop of wind production of 800 megawatts in one hour, so the question is, in that context, would storage help? Or how do you currently respond to that sort of drop? And that’s with current levels of wind, presumably, as we increase, you could see much larger swings. And that was down – I suppose you could also have massive, you know, similar swings upward.

MR. ROTHLEDER: Yeah, we see both ramp-in and ramp-out of wind and it is increasing the amount over the hour and even intra-hour is increasing. The storage, one arena it can help, is providing regulation, so the initial way the system balances for any drop within the five minutes is going to be the regulation of the system. Usually we have about 300 to 500 megawatts of regulation on line, ready to meet that change. That will probably increase as we see increased amounts of renewables. So that’s the first thing. And we’ve removed barriers to allow storage to participate and provide that regulation service. Over the rest of the hour, to the extent storage devices can provide longer deliveries of energy utilizing those devices as dispatchable resources, we basically have a five-minute dispatch market, basically balancing the system kind of behind or ahead of regulation. That's where that balancing would occur. And having storage resources that are dispatchable, that can provide energy over longer periods of time, does provide that capability.

CHAIRMAN WEISENMILLER: And you mentioned over a long period of time, although your chart indicates that, at least for the battery context, you're looking more at 15-minute increments, as opposed to over an hour.

MR. ROTHLEDER: Right, so that would be more in the regulation rather than using it as a dispatchable resource within the hour.

CHAIRMAN WEISENMILLER: Yeah, now in terms of if you could get the intertie scheduling to be less than an hour, but more intra-hour, how would that compare to storage, if we could go to a 15-minute or five-minute, even, on the interties?

MR. ROTHLEDER: Yeah. So, there's two types of ramps from the interchange, one is scheduled ramp that actually occurs every hour over the 20-minutes across the hour boundary, that's one form of ramp. As we allow for more resources to dynamically schedule, especially renewable resources to dynamically schedule, they become effectively like internal resources, internal to the balancing authority, and so it will just increase the amount of variability that the ISO will have to accommodate as we see increased amount of dynamically scheduled resources.

In terms of having the intra-hour schedule capability, you still have the change of the schedule, you can break it up, breaking it up over the hour in 15-minute increments reduces the burden for balancing, there's no doubt about that. Also, having the forecast of that change ahead of time allows the operator to lean into and prepare for that change. However, it doesn't – the variability will still occur, it'll just come in smaller granularity chunks, and having that occur that way will reduce some of the burden, but I don't think it is an alternative to having dispatch capability to balance the system on a regular basis. It reduces the burden.

CHAIRMAN WEISENMILLER: Okay, so switching gears, we've talked about variable resource, going up or down dramatically, the other system operational issue that you have to deal with is, let's say, SONGS kicks off now, or we use an intertie because of a fire and you have 10 minutes to respond, and obviously this could be at night or any time during the day, how does that work, or how can storage help in that situation? Obviously, presumably, those events could be more like multiple hour if not day or week or month events for responding, but at least in the first 10 minutes you have to respond on a frequency side.

MR. ROTHLEDER: Right, well, what you describe there is more of a contingency event and that's exactly what the purpose of operating reserve is for, spinning and non-spinning reserve ––

CHAIRMAN WEISENMILLER: Right.

MR. ROTHLEDER: -- and that really is there, it's held in reserve, it's not being dispatched to normally balance the system, but it's there in preparation for what you describe as a contingency event. And in that regard, storage devices could play a role in providing those types of operating reserve services, they can deliver in 10 minutes, and then we can utilize other resources to start to fill in the need and return the reserves over the rest of the hour. In fact, we can dispatch other resources, allowing us to basically restore the energy and the storage device, and be ready for the next contingency event. The way the operating reserves works is, if you deploy your operating reserve for a contingency, you have to deploy it in 10 minutes, but then you have basically the balance of the hour to restore it.

CHAIRMAN WEISENMILLER: Right, so I assume that operational reserves are primarily your CTs?

MR. ROTHLEDER: CTs play a role in the non-spin; oftentimes, the spinning is being provided by hydro resources, resources that are already spinning, some steam resources. So, the CTs are good for providing that non-spin.

CHAIRMAN WEISENMILLER: Okay. Now, the other sort of contingency, what you mentioned is sort of the over-generation issue.

MR. ROTHLEDER: Yes.

CHAIRMAN WEISENMILLER: So, you know, given again, say this month as we're moving into the high hydro periods, and you have the potential ramps up or down in renewables, how do you deal with over-generation? And what's the role of storage in responding in that contingency?

MR. ROTHLEDER: So, over-generation condition, first, obviously, we don't consider it a contingency, it's you kind of develop into it as your supply exceeds your demand. Currently, we have storage devices, the large hydro storage devices at those times when we start to see the generation exceed the demand, we'll start to dispatch and turn on the pump devices to consume some of that over-supply. To the extent we run out of the ability to turn the pumping devices on, we then basically are utilizing market mechanisms. In the first place, you'll start to see prices basically drop below zero. Right now, our bid flower is -30, so we are starting to now at that point sell or pay people to basically take the energy either off the ISO grid, or consume more. To the extent there are devices that can actually be ready to consumer more, such as storage devices, and be prepared to be compensated for storing or consuming that energy, that's one form of managing the over-generation condition. If we get to the point where we've exhausted our market mechanism to back everything down, there then becomes procedural mechanisms where we may have to basically tell a group of resources, or all resources, to start backing off and/or shutting down to balance the system. That starts to come into the realm of an energy condition where we have over-generation. I wanted to say that some of the things that we're doing on the bid floor to incent more curtailment of renewables and incent resources that are able to store, we are considering lowering our bid floor to something in the neighborhood of negative $100 or $200 to overcome some of the incentives that some of the renewable resources have for actually producing.

CHAIRMAN WEISENMILLER: Yeah. I assume, unless you do that, what will happen is the renewables will generate, but instead of backing out fossil fuel and reducing our fossil fuel use and our greenhouse gas emissions, that we just continue to generate and sell the power at a loss, so we don’t get the environmental benefits, or both the environmental and economic costs associated with the additional renewable generation, in those conditions without the storage.

MR. ROTHLEDER: Right. Certainly, storage devices that we can store the energy and use it during peak times that will shift that ability around, so that is a good use.

CHAIRMAN WEISENMILLER: Well, I think I’ve hit my points. Thanks.

COMMISSIONER DOUGLAS: All right, I have no further questions. Thanks for being here.

MR. ROTHLEDER: Thank you.

CHAIRMAN WEISENMILLER: My other Commissioner has a question.

COMMISSIONER PETERMAN: Hey, Mark, good morning.

MR. ROTHLEDER: Good morning.

COMMISSIONER PETERMAN: Just a quick follow-up question for you. When reviewing the list of energy storage technologies in the presentation, some seem more suited to readily be dispatched by the ISO than others, and I was wondering if you could comment, in particular, on how you would aggregate electric vehicles and use that as a dispatchable storage device.

MR. ROTHLEDER: I think the first thing is, as technology changes, and the tools that the ISO needs to use, they need to be mature technologies and what we see in terms of electric vehicles is potentially in the future with smart charging capability, they start to potentially act in a way with that capability if there is monitoring the system, monitoring the signals, they could provide things like regulation service, they could also potentially time their charging so that you can shift some of and take up some of that slack in an over-generation condition. How that will all play out is something that we need to continue to work together on as the number of electric vehicles and the technology of electric charging stations really evolves.

CHAIRMAN WEISENMILLER: Mark, I was going to ask you one more question, thinking about that stuff. So, we have talked about the three types of things, obviously in terms of the variation in renewable generation, you’ve seen 800 – it looks like in your charts, you could see up to 2,000 of a swing in an hour. And in terms of the more loss of generation and, again, those are the large units, so it’s about 1,000, how deep an over-generation period have you seen? Or do you expect to see?

MR. ROTHLEDER: From the studies we’ve done, it looks like the over-generation condition is probably going to be somewhere in the neighborhood of 500 to 1,000 megawatts at times. And it really does depend on the way the patterns are with the wind producing at night, if you get into that springtime period with the spring runoff, and you have the combination of the high hydro flows, low load, high wind production, that’s going to be the worst time in terms of over-generation conditions.

CHAIRMAN WEISENMILLER: Assuming that nukes are out or not out on maintenance –

MR. ROTHLEDER: Well, oftentimes, yeah, the timing of those maintenance are sometimes good in the sense that they do come in the spring. When they come back for maintenance, we do see times where they do exacerbate the over-generation conditions.

MR. GRAVELY: Yeah, the question was in general, the East Coast ISOs and how California is addressing the FERC requirements as compared to the other ISOs.

MR. ROTHLEDER: Yeah. I think with our recent developments of the regulation energy market system, and some of the changes that we've made, I think we're probably catching up to some of the things that are happening at the other ISOs. I will say that other ISOs that do have capacity markets have incorporated storage demand response into those capacity markets. In California, with the capacity being acquired through the resource adequacy mechanism, there is not – I think that needs to potentially evolve to incorporate some of these other devices. So, I think we're, in terms of meeting FERC directives, we're in the progress of responding to some of their more recent directives. Some of the recent directives are becoming a bit more challenging in terms of how to consider and dispatch demand response, non-generator resources, and how to price that into the system and when do you start dispatching that. There is some interaction and interplay with all the ISOs with FERC on that subject, and we'll be looking forward to understanding better how to do that.

MR. GRAVELY: So, before our next speaker, I want to add one thing. This comment has come up a couple times, and for those of you that did not participate on November 16th, we had a considerable discussion there about automation of demand response and the capability of Auto-DR to serve as an ancillary service. Most people are familiar with DR as a load reduction, load shifting technology, we've been doing research in the PIER Program for over eight years, and as we automated demand response, we realized the response could occur pretty fast and the current technology range of 30-40 seconds, future technology could be five to 10 seconds, and then it would last for 30 minutes or longer. So, when you look at that performance, it's very similar to storage. So, we started looking at using Auto-DR as a complement, or alternative to storage, primarily because if you put the system in for peak load reduction, and it's available for anything, and the cost factor is substantially less to use that, so when we talk about DR and Auto-DR, we're talking about both as a peak load reduction load shifting, and also as a potential ancillary service, and there will be a short presentation in the afternoon from the [inaudible] Research Center for a few minutes, just recapping what we covered in November. Those who are interested can go to the website, the script is there, the audio is there, and all the presentations are there to cover that because we did discuss it in a lot of detail last time.

We're now going to shift to a presentation by the Department of Energy. We're fortunate to be in a timeframe where there are more large storage projects currently being demonstrated in the history of – I've been involved in storage for 20 years, this is the most I've ever seen. And the good deal is that 2010 was kind of the contract award phase, 2011 is now the demonstration performance phase, so a lot of these projects are now reaching installation phase and getting into the actual phase of putting the systems in, and we'll start to see their performance.

We're going to have a presentation now by WebEx from Michael Kintner-Meyer for Imre Gyuk and will provide a quick review of all the activities DOE has in this area, and what they're learning, and where they're going forward. So, Michael, are you online?

MR. KINTNER-MEYER: yes. I am on the line. Am I advancing the slides? Or are you doing it from your side?

MR. GRAVELY: I think we're going to do it here, so just confirm what slides you want us to have and we'll be advancing them here.

MR. KINTNER-MEYER: Okay. Thank you very much, Mike. I'm delighted to stand in for Imre Gyuk, who is leading the Energy Storage Program at the Office of Electricity, Department of Energy. I'm trying to the best of my ability to convey the tenor that he would have given to this presentation. There will be several questions that I may need to refer to him at the end of this presentation.

PNNL is part of the laboratories supporting Imre in his project; I'm personally supporting him with Grid Analytics. Next slide, please. Imre usually starts off there by quoting a couple of important people there as to what has changed to the recent years with respect to energy storage, and he shows there statements by these three fairly important people with very powerful messages, and as an indication that the notion of research, as well as the actual application of energy storage has changed in the last two years. Next slide.

This slide shows the role, the Federal role for the eventual implementation of deployment of energy storage, starting from basic research that the Department is doing in collaboration with the Office of Sciences, looking at materials to advance the technology to a systems design of a lower cost and higher performing batteries, which then is under there with the right of regulatory framework as we see here through FERC Order 890, the California mandate that you see here, as well as tax incentives from the Federal Government as we're seeing there in the bill that was introduced by Senator Bingham, the Energy Storage Act of 2010, which is still in discussions.

So we’re seeing a trend from a regulatory environment, certainly not quite complete, under verdict [ph.] with funding for the technology, as well as demonstrations and loan guarantees to bring the technology into the marketplace. Next slide.

Imre feels strongly about the change there in the significance and recognition there of energy storage as a catalyst of not only addressing the issues that we have heard Mark, the previous speaker, articulating for the California ISO, but fundamentally being able to operate the Grid in different ways because of the special characteristics that we have not really had before. There has been some collaboration there between the Federal Government and the PIER Program through an MOU with the CEC to collaborate on various levels, and hopefully this will continue in the future. One of the collaborations there centers around demonstration of flywheels, that involves the California ISO. Next slide.

To establish a roadmap for the Federal Government with respect to a design of a program to support energy storage from a technology innovation point of view to the eventual deployment, the Office of Electricity conducted two workshops last year, one that looked at utility requirements, what does the utility need, what are the costs, targets, what are the performance targets to be competitive and cost effective as a Grid asset, and then also from a science and technology innovation point of view, looking at new materials and systems of how to put these technologies together into reliable and cost-effective technologies. These two workshops produce some individual reports, which are available and are now influencing the energy storage roadmap or program planning document, which was published in February and is also available on the website. Next slide.

As far as the appropriateness of energy storage is concerned and the specific operational characteristics, we're seeing a broad spectrum. It is driven by different applications, so we have variable products, iPods which require energy storage to hybrid vehicles, military applications to utility applications. So that spans a whole several orders of magnitudes in the power requirements and, therefore, will most likely require different technological solutions for different applications because of the disparity in the requirements regarding footprint, energy density, as well as the footprint for the installation of the devices.

So, we would expect that the materials and the electro chemistries necessary to meet these different operational requirements may differ and, in fact, we're seeing quite a plethora of different technology innovations for specific applications. Next slide.

You have seen this slide many times, let's step and go to the next slide, please. Let me talk about several of the Stimulus activities and go into a little bit more detail as to what the Office of Electricity through the Stimulus factors is supporting. The total budget from the Federal Government, $185 million, supporting new projects and scaling really up to demonstration by a factor of 10, which raises the expectations that we will get significantly more insight in how the different new technologies work, how they're being applied, what are the lessons learned, what are the business models being applied, what are the degradation characteristics of individual technologies, how many different services can one technology capture as they're being deployed and experimented with. You're seeing there some spectrum of different technologies for different applications, large batteries, compressed air, some very large devices, frequency regulation, distributed project with smaller devices, and other technology development. This entire Stimulus package is required from cost sharing and actually exceeded the expectation of the 50-50 cost sharing, and leveraged three times – almost three times the investment by the Federal Government. Next slide.

I’d like to go into some of the applications as we see them being deployed through the demonstration of projects that are funded by ARA. The first voltage and frequency regulation market that we’re seeing is already ready, we’re seeing their companies deploying technologies and actually making some money. Next slide.

The fundamental primacy of regulation services is very similar to what Mark indicated, a means by which we balance to maintain frequency, the utilities have been doing this for a long time with the intermittencies of renewables, those regulation services are expected to increase and we think there is a market for some storage devices. Next slide.

So we’re seeing some demonstration and it started off with some flywheel demonstration that is seen in the upper left corner, in a trailer to 100 kilowatts of flywheels that was collaborated there with the CEC, and through the ARRA project, this has been upsized now to 14 megawatts that will happen in the PGM footprint, going on to an expected 20 megawatts. There are lithium ion experiments done with two one megawatt units with energy capacity of 15 minutes, and the lessons learned from these early demonstrations really culminated there in two major outcomes, one of which is that if regulation is done by fast responding Grid assets, that the effectiveness that it provides to the Grid is what is estimated to be twice as much as that of a gas turbine, so speed of responsiveness has a value. The second outcome is that, if you take away the requirements from some thermal power plants to go up and down, you can keep them at a much more steady performance, steady output, rendering higher efficiencies, as well as lower emissions. And so the variability could be offloaded to the energy storage, and would improve the overall emissions footprint. Next slide.

This is some rendering of the Beacon Tower installation, again, that is a 3-D image showing what it will look like. This installation is for a frequency regulation services and the PGM footprint on the lower right-hand side you are seeing here the flywheels, the individual flywheels, and are composed together to make up 20 megawatts. Next slide.

Just another picture on the upper left corner of the Beacon power plant that's currently – that's actually on line, that is the 14 megawatts, and on the lower right-hand corner you're seeing the AES installation with A-1 through 3 batteries, a total of 20 megawatts providing regulation services for the New York ISO. What you're seeing, actually, is eight megawatts, about two megawatts per trailer, that will be added to -- the additional capacity will be added to make up a total capacity of 20 megawatts. Next slide.

Peak shaving energy management and infrastructure operate deferral. Imre sees this as near commercial, in other words, cost performances are not quite there to be fully competitive, but we do see some demonstration to target that application, as well. Next slide.

On the upper portion of the picture, you're seeing an application of a sodium sulfur battery that has significant energy capacity of six hours maintaining an output of 1.2 megawatts where this is deployed for several years at a substation to reduce the overall loading on the substations. This was installed as an alternative to upgrade the substation primary transformer, and it's still in operation. Next slide.

On the distributed side, those are smaller devices placed either at the substation or further down in the distribution feeders, various different technologies are being tested, you're seeing here the different electro chemistries and the different sizes. Key applications are peak demand shifting, but can also provide regulation services to a point of aggregation that would meet the ISO market threshold of a megawatt, so you can aggregate those up if they have direct control to a Grid operator to be utilized for Grid bulk power services. Other applications are for smoothing and assisting voltage issues in the distribution feeders, and sometimes you get protection issues by reversing the power flow upstream, and with energy storage down in the feeders that could be prevented. Next slide.

This is a three megawatt frequency regulation demonstration in Eastern Pennsylvania where advanced lead carbon batteries are being tested. In the upper left corner you’re seeing in red the cycle and degradation behavior as a function of cycles, and you’re seeing that these new batteries, the new lead batteries performing much longer, as opposed to the conventional lead acid battery as shown here in blue. Next slide.

This is a representation of AEP’s community energy storage system. Here, the value is co-locating it right next to a secondary transformer that provides electricity to three, four, five homes, and the battery there is providing smoothing capabilities, again issues there for voltage control down in the feeders, as well as frequency regulation capabilities if coordinated in a central control paradigm. Next slide.

Another application of community energy storage systems in the DTE or Detroit Edison's service territory, here co-located with photovoltaic installation at a community college, you see here A-1, 2, 3 batteries, small size batteries, 25 kilowatts output for two hours, that was sized to help us smooth the output from the photovoltaic arrays. Next slide.

Different – I think we can go to the next. We also are seeing the convergence of transportation batteries being utilized in the stationary energy storage system A123, for instance, past transportation batteries provides transportation energy storage devices, and is also looking at stationary storage applications with fundamentally the same electro chemistry. The Department of Energy is funding a activity that is looking at the reuse of electric vehicle batteries, as you see here the general participants. The notion is that, from a transportation purpose, the battery reduces its capacity by 80 percent, so, in other words, if the original battery provides less range than 80 percent of the original design, it will be replaced with a new battery. The old battery can then be re-packaged for stationary application, and the viability of doing that and the economics of it is being investigated by these partners in that consortium. Next slide.

So there is a forthcoming report coming out in Oak Ridge, a report looking at the economic factors, net present value analysis of such a value proposition, so it's repurposing transportation batteries for the purpose of supporting the Grid. Next slide.

Renewables Dispatch, Smoothing, Ramping and Peak Shifting. This is a key driver of the discussions that we're having. Next slide. So we're seeing the Department of Energy through their ARRA project is supporting three large battery demonstrations there that are coupled with wind projects. Next slide. So one is with Primus Power, a 25 megawatt three-hour battery plant in Modesto that is operated by the irrigation district, California Irrigation District, firming up wind and thereby replacing a $25 million gas-fired generation plant, so this is a flow battery, and the value that it is trying to capture here is wind smoothing. Next slide.

Similar application, Southern California Edison, collaborating with A123 on the lithium ion battery, that will be located at a substation close to the Tehachapi

Wind Power Plants. The primary purpose is wind smoothing, and there will be other controlled strategy tested during the lifetime of this project. Next slide.

Compressed Air Energy Storage. Okay, it's a mature technology. Two power plants operating for several years, one in Germany and the other one in Alabama, I think that technology is fairly well matured. Additional geological formations are being explored here in the United States and the ARRA funding mechanism is supporting that activity. Next slide.

This is a collaboration with NYSEG in New York State, again, the activity centers around finding the appropriate geological formation and cavities to provide the right encapsulation for compressed air to be stored and in the right vicinity of transmission lines, and wind, so that potential congestion issues might be avoided. Next slide.

This is the PG&E compressed air energy facility activity. Again, here it is identifying the right geological formations, the right placement of the cavity of the storage medium, several different depleted grass fields are available and the activities are beginning to look at geological formation testings. Next slide.

Pump hydro, we're seeing here overall some interest in pumped hydros, several different projects, particularly in the west, have been applied for permitting with FERC. Currently we have 20 gigawatts on line, several more gigawatts are in the permitting stage. Again, a fairly mature technology, this, however, as mentioned before, some new pumping technology being tested that has variable speed pumping capabilities to allow balancing services or regulation services in both modes, pumping as well as power generation providing a broader application opportunity for a pumped storage.

We're seeing on the right side an interesting plan by grasslands, they're trying to aggregate a pumped hydro with wind to have dispatchable green power, so where the generation from wind plants will be bundled with storage to make it dispatchable and firmer. The idea is to build additional DC lines to Los Angeles to serve the California market. Next slide.

Imre used this slide as a reminder that energy storage could be in the form of cold storage or ice storage for peak demand reduction and even some researchers looked at using it for regulation services, as well. So it doesn't necessarily have to be electric energy storage, there's also opportunities in very very conventional ice storage that the industry has deployed and maybe there's a renaissance of thermal energy storage that we’re seeing there for commercial buildings. Next slide.

Some new technologies on the horizon. I’d like to mention that the DOE program is also supporting technology development and materials, the development of new materials for the next generation of stationary energy storage. We are seeing here five new technologies that are coming to the fore, and being able to be tested as prototypes, sodium ion batteries, new advanced flywheels, we’re seeing some iron chromium redox electro chemistries, and additional lithium ion, and then an interesting compressed air storage that has nice characteristics with respect to avoiding to use gas as the energy storage is discharged. Next slide.

This shows the aqueous sodium ion battery. The key here is this is relatively low cost. Sodium material can be utilized with relatively high energy efficiency. The challenge is to provide the lifetime necessary to compete in the marketplace. Next slide.

We’re seeing here yet another, a different electro chemistry being deployed that has a fairly high energy density, and therefore the capability to reduce the materials cost for developing and for building such a device. Next slide.

This is a compressed air technology that is utilizing hydraulics, so it is an isothermal process that doesn’t need to have reheating as the air expands, and therefore can be operated without using additional gas during the expansion process. Next slide.

So, the overall premise of the DOE program is aggressively furthering the market pool through analyses, Grid analyses, articulating value proposition for different market niches, as well as technology pushed by advancing technology into innovations, and demonstrating it in the field. Next slide.

So, the goal is, as Imre states, to make energy storage ubiquitous in the Grid. Next slide. I think the last slide has some resources of the program. Sandia has a website dedicated for hosting all of the information that is published through the DOE Energy Storage Program. There is a handbook and Imre likes to remind people that the next Energy Storage Application Technology Workshop is coming up in October this year in San Diego. I think that is the last slide.

CHAIRMAN WEISENMILLER: Okay –

MR. KINTNER-MEYER: Happy to answer any questions.

CHAIRMAN WEISENMILLER: This is Chair Weisenmiller again. First, I’d like to really thank you for your participation in this. You’ve certainly given us a lot to think about, and also we'd like to thank you for your joint activities with our PIER Program, and for helping get some demonstration projects in California. I mean, as you indicated, we are certainly pushing the envelope on a lot of the renewables, so we see this state as a good test bed for some of the storage technologies.

A few questions. The first one is, I noticed you quote Secretary Chu about the need for technology breakthroughs for large scale energy storage. Again, it's back to that basic question of do we need volume, or do we need technology breakthroughs at this point, realizing that there's a plethora of applications, a plethora of technologies, so it's hard to generalize, but what do we really need now, volume or breakthroughs?

MR. KINTNER-MEYER: It's a good question. At the end of the day, I think that if the market signals are set properly, it may work this out by itself. I think what has been mentioned there early on is that this is not the only technology rubric of providing Grid flexibility to the electric power system. I think we've seen there, particularly with the emerging electric vehicle fleet, opportunities to address all of the three issues that Mark from the California ISO addressed, over-generation by charging, by having new load come on line most likely at night, when these low load conditions occur, ramping capabilities, the load can respond much more quickly than a thermal energy storage even than a pumped hydro or hydro power plants, and certainly can provide regulation services, as well. So, as to the question of how many gigawatt hours do we need in terms of stationary energy storage system, is still a question. We're trying to address the total market size in our upcoming efforts supporting the DOE program, by looking at from a cost-effectiveness point of view as we've seen, new requirements being driven by the intermittency problem, nationwide, what would be a prudent deployment strategy that is cost-effective for stationary energy storage, so that we'll look at existing capabilities and the potential retrofitting of existing capacity to make them more flexible, as well as transmission expansion, as well as Smart Grid technologies on the load side.

CHAIRMAN WEISENMILLER: Okay, the next question is, you mentioned pump storage and you mentioned the variable speed pumping problem. California has a couple of very large pump storage facilities already, Helms-Castaic, for example, we also have a lot of poundage hydro as opposed to the run of the river in the water system. Is there any effort at this point to come up with demonstrations for cheap retrofits of those facilities to make them more efficient or more useful in the current needs of storage for renewables? That seemed to be an area where you don't really have a demo but, again, we have existing facilities that, if we can convert, that would give us lots of capacity very fast.

MR. KINTNER-MEYER: Yes. There is a recent announcement, a funding opportunity announcement, by the Department of Energy, it just hit the road on April 5th, that comes out of the Office of Energy Efficiency Renewable Energy, the Hydro Power Program Office, and it's charging toward valuation of advanced pumped hydro and conventional hydro power plants, and they specify this for the WECC to be demonstrated in the WECC as a opportunity for funding, so there is a deployment activity embedded in it, as well as an analytics element. So the Department, not through this program, but through the Energy Efficiency Program, is addressing this.

CHAIRMAN WEISENMILLER: That is very good. The other question was that, on your slides you indicated some of the storage projects are getting loan guarantees from the Federal Government to move forward. I assume that deals with the perception that the technology has some risk and that the financial community is looked for those types of guarantees? Is that the case for the flywheel and the lithium ion battery projects?

MR. KINTNER-MEYER: I need to refer that to Imre as to what the rationale for selecting these projects are.

CHAIRMAN WEISENMILLER: Okay. And the last question was, you've got a lot of very interesting demonstration projects going on here. So far, have there been any surprises in terms of the actual performance as opposed to the expected?

MR. KINTNER-MEYER: Most of the – the contracts have been put in place last year and they're just in the procurement process, it's a little too early to get even preliminary information. So it's a little early.

CHAIRMAN WEISENMILLER: Okay, thanks.

MR. KINTNER-MEYER: But there will be forthcoming the entire projects have a five-year lifetime and information will be made available through the National Energy Technology Laboratory.

CHAIRMAN WEISENMILLER: Great. Thank you for your participation today.

MR. KINTNER-MEYER: Thank you.

MR. GRAVELY: Thank you very much and we appreciate it, and feel free to continue to listen in and we'll have a chance later also for comments or questions if you have some.

We're now going to shift to the first panel and we have three speakers in the panel. The speakers can provide opening comments. I'd like to try and keep those comments to less than 10 minutes each, as necessary, so we have a chance for some discussion. So if I can get Amanda, Mark and Dan to the table here, if you can speak from the table, the mics are live, or you can speak from up here, however you want. If you have a presentation, you can, again, speak from up here or we can actually do it, so we'll go with the presentations in the order. First, we'll hear from the California Energy Storage Alliance, Amanda Stevenson, and then we will hear from Mark from the ISO, and Dan from EPRI, and then I'd like to be able to have some time for questions and discussion. We have some questions already proposed in the agenda, but I'd like to get a chance for the dais to ask questions and we'll go to those questions if everything is answered. So, we'd like to have a little more chance for dialogue this time, so please hold your form of comments or your presentations to 10 minutes or less.

MS. STEVENSON: Hi. I'm delighted to have the opportunity to stand here and discuss the importance of energy storage to California's renewable future on behalf of CESA and Xtreme Power. A little bit about CESA. Our mission is to expand the role of storage technology to promote growth of a renewable energy to create cleaner and more affordable and reliable electric power system. Our core principles for a healthy market, technology neutrality, ownership and business model neutrality, and as we do have limited resources, we do have to be very focused in our efforts working with the California Legislature, CPUC, CAISO, CEC, CARB and FERC.

To date, one of the barriers of storage are the silos and the decisions that are made in the silos that determine the market structure and compensation for energy storage, so there is a need for regulatory focus on storage to make positive changes to California’s current Grid.

Grid storage leaders founded CESA in January 2009. CESA is a broad coalition, currently 37 members strong, and spans pretty much every storage technology available.

A little bit about my company, Xtreme Power, we’re a U.S. based, vertically integrated developer, a manufacturer of dynamic power resource, which is a utility scale, battery-based energy storage system, 20 years of R&D in our technology, tested and proven, projects operating, contracted, and final negotiations in more than 70 MVA and more than 60 megawatt hours. We have U.S. based manufacturing in Oklahoma and Texas. And as we can see here, energy storage is a very broad asset class, it is very diverse – mechanicals, flywheels, pumped hydro, electrochemical, advanced lead acid batteries, thermal molten salt and chemical, different types of storage have different types of characteristics, all for very particular uses. There are many options from Grid scale to smaller DG batteries. While there are many new technologies, let's not forget that storage has been around for decades and decades and is quite a mature industry, but what is new is its applications to the Grid.

So, as you can see, there are a lot of commercially available technologies that you can put onto the grid right now, and they all have a role to play on our grid. There is not an issue or a question of commercial readiness, it is deployable now.

Why energy storage in the U.S.? We do have Renewable Portfolio Standards here in California. There is legislation in the background that encourages the valuation of storage procurement targets, but implementation of AB 2514 can better be assisted with the CEC's leadership and direction on which application and storage – and there are many – to prioritize and focus on. California needs the CEC’s support to accelerate near term deployment of more energy storage. The logic being, if you have more projects on the ground and progress, you will have more informed implementation of AB 2514.

There are a lot of things the CEC has already done with their support of renewables with special financing programs and incentives, but the opportunity now is to be a leader in California and spur the action in near term.

I know Michael did go through some of the fundamental key policy initiatives in California, so I’m going to focus on AB 2514 and AB 32 Global Warming Solutions Act of 2006. AB 2514, an unprecedented energy storage portfolio standard, establishes energy storage requirements for the IOUs to integrate 20,000 megawatts of new renewables onto the grid, and to help deal with peak demand and the dirty peaker plans. What the bill does is it directs the CPUC to convene a proceeding to evaluate energy procurement targets, if any, if commercially feasible and if cost-effective. I think when we start focusing on storage, a lot of those ifs will go away.

CAISO is holding stakeholder sessions to ensure that California will allow applications for storage, as we did hear Mark earlier, state that storage technologies provides a flexible resource for maintaining reliability, and FERC recently opened a new rulemaking on ancillary services that would pay DR storage and other fast acting ancillary services for their speed.

So, why energy storage now? It can meet RPS more efficiently with storage. My diagram here shows we can meet RPS without storage, we increase a percentage of renewable penetration, which will then increase the regulation requirements, which will then increase the thermal generation production and will further dilute the percentage of renewable production. To reach its 33 percent RPS, CAISO must increase regulation by 165 percent, and I do have the cites on the bottom if you guys would like to look at the White Papers done on that study. To meet RPS with storage, increase the percentage of renewable penetration, increase regulation requirements, increase zero low sustain limit ancillary services with storage, and then you achieve the Renewable Portfolio Standard.

Other key drivers of growth for Grid storage. I know it’s a pretty advanced group here, but I wanted to point out some of the underlying key drivers for the foundational legislation. Firstly, peak load growth;

obviously, as population grows, peak demand grows, especially in California where air-conditioning is utilized. The peak dictates T&D cost and that is a significant chunk in the electric cost associated with the power Grid. CEC predicts that average peak demand will grow by 1.3 percent to 1.4 per year between 2008 and 2018, with residential peak growing at 1.9 percent per year.

Smart Grid, every definition of the Smart Grid includes storage as it is really difficult to have a reliable Smart Grid if you don’t have storage. Renewables integration, storage and renewables can work synergistically together to optimize the current grid. And transmission constraints, this is the perennial problem, California is famous for its Nimbyism, everyone likes to have their TVs, computers, and appliances plugged in, but they don’t want wires in their backyard. So, every storage will help in the investment of the public electric power system that we already have.

Another key driver, Global Warming Solutions Act, 2006, AB 32, it reduces GHG emissions. The main driver of storage that the environmental communities are excited about, that storage has the ability to dramatically reduce GHG emissions. The brown line here shows the tons of CO_2 emitted per megawatt hour on a variable basis of our peaker plants. Those are the plants that generate electricity on peak that tend to be less efficient and generate more emissions. Then, the aqua line shows baseload plants or fossil plants, so this shows the difference throughout the year. So, even in the wintertime, peakers are not as clean as the baseload. The state is consistent throughout three investor-owned utilities, so you can imagine charging your storage system with baseload energy at night and displacing these peakers with energy storage, you would have an improvement in air quality.

So, why energy storage and renewable integration? Enhancing renewables with the Grid scale energy storage promotes reliability and sustainability. Energy storage can transform variable generation into dispatchable or baseload generation, all while generating no emissions and without using nonrenewable fuels. And in the essence of time, I won’t read every bullet point.

There is a value in intelligent, accurate, and sub-second power management, increases delivery from renewable generation, helps to achieve RPS, fast-acting ancillary services, it’s more efficient, and an economic solution for Grid reliability. Of course, ramp rate control, renewable capacity firming, it can shave peak demand synergistically, and it is emission free peak capacity.

Frequency regulation, why is it important? Balances fluctuation and load and variable energy resources, maintains Grid frequency, and critical for any Grid sustainability and operation. So, why is storage a great solution? It's an instantaneous fast response, it provides no unintended energy to the Grid, and it is high efficiency. Benefits of fast response, storage is two to three times more effective than a peaker, it's faster, more accurate, generation must chase the faster moving load, and conventional generation can provide regulation in the wrong direction.

Energy storage can provide peaking capacity without fuel use, water use, emission pollution, and being located fair from the load. CT's in California are generally sited far from population because of the emission issues; energy storage peakers could be stored near loads, which would be much more efficient.

Storage can shave peak demand synergistically with renewables and here is a solar example, and as AB 2514 covers all applications of storage and details are to be worked out by the CPUC, but I wanted to take a moment to talk about distributed and small renewables that can be powerful and have a Grid scale impact to our system. This chart from EPRI shows a day in the life of the CAISO and what would happen to our load shape with storage as it fluctuates. The black is the load shape, blue is the net of the California solar initiative, and the red is what our load shape would look like on a sunny summer day if 5 kilowatt hours of storage were installed for every kilowatt hour – I'm sorry, excuse me, every kilowatt hour storage, and that's pretty impressive because there are a lot of costs, it's bundled into the peak right here. And I wish I had a little pointer, but I don't.

Real projects, real solutions, not just R&D, here I want to show, at XP, that we do have seven projects that are either operating now or are in the design phase in 2011, various services, peak shaving load leveling ramp rate control ancillary services. This is one of our wind farms at Kaheawa Wind Power on Maui, it's the first utility scale DPR that operates 30 megawatt wind farm and the service for that is ramp rate control.

I guess I'll run through the proof of performance and this was discussing the wind ramps up and the state of charged storage absorbing power, and when the wind ramps down, storage discharges their power, always constantly holding that state of charge. I'll run through these.

Here is our Kahuku wind farm on Oahu and this is operating to meet PPA ramp control smoothing requirements, and the reason I wanted to show you this, I just wanted to show you that it's not still R&D, that we do have real projects in the ground, and we are getting data from these projects. This was actually taken last month during our commissioning event where there were four wind turbines that tripped off line causing an 8 megawatt drop in power, you can see in the green; the red line was our DPR, Dynamic Power Resource, and what the utilities saw the total park power controlled that ramp rate. So, even with better forecasting efforts, your ramps and trips can be scary for the ISO and that's where storage can come in.

And this is our last slide here, our Duke Notrees project, it's the largest battery energy storage system in the world. We partnered up with Duke and with the DOE funding, and this system is being designed to optimally dispatch production from a wind farm to provide system balancing and ancillary services to the interconnect. And it will be instrumental in establishing cost and benefits in the ERCOT ISO in Texas by verifying technical performance and validating system reliability and durability at scales that will benefit the increasing penetration of renewable assets nationwide. So, we should do it here in California, too, we'd like to bring some projects to California.

CHAIRMAN WEISENMILLER: Okay, thanks. I guess the question I have for you is whether your applications were project financed, or did they have DOE support, or some support in this stage?

MS. STEVENSON: Most – well, the Duke Notrees project was DOE financed, the rest were privately financed.

CHAIRMAN WEISENMILLER: But were they project financed or venture capital or –

MS. STEVENSON: Venture capital.

CHAIRMAN WEISENMILLER: Okay, thanks.

MR. GRAVELY: Mark, would you like to speak from up here or –

MR. ROTHLEDER: No, I'll just be brief. I think I said most of what I wanted to say in my original presentation. Just that we got two things that are happening, one is the variability of the system is going to be increasing between now and 2020, while at the same time the resources that provide the flexibility to respond to that variability are reducing. We know the once-through cooling resources will be either retired or repowered, so I think between now and 2020 there will be an opportunity to replenish and decide how we redesign the system to support the flexibility needs of the system. And I think our studies and our continuing studies will help shed light on how much, what kind, and hopefully that will help provide some information about what kind of storage resources, and how much would be needed.

CHAIRMAN WEISENMILLER: Thanks, Mark.

MR. GRAVELY: The next panel member will be Dan Rastler from EPRI and he'll cover a quick little review of the effort they're doing and how it fits into the questions we have here for the need of storage. Thank you, Dan.

MR. RASTLER: Thanks, Mike, and thanks for the invitation to participate. I'm the Program Manager of the Energy Storage Program at EPRI. We have a broad industry collaborative of over 40 utilities currently sponsoring the program. I'm very happy to be also collaborating with the California Utilities as part of our collaborative program. Many of my remarks this morning really come out of our research program, and I've sort of spun, I think, a lot of EPRI strategy and sort of thoughts around these questions, right out of our program, which is trying to address issues across the country, not just in California, but there is a lot of similarities, I think, to what we see here in California, to what we see across the country. So, the drivers. And, again, these are drivers we see with a lot of our member utilities across the country, and I won't dwell on these a lot this morning, we've already heard about it, but obviously the three big drivers are dealing with larger penetrations of intermittent generation, managing the grid assets. The industry is expected to spend over a trillion something dollars over the next 30 years on infrastructure, and that could also increase more as we try to manage renewable resources.

We're also seeing a lot, particularly in California, a lot of penetration of distributed photovoltaics down at the lower voltage regions of the Grid. And storage is being looked at as a possible option toolbox to deal with increased penetration of PV. And, of course, as was just mentioned, the Smart Grid and storage is an asset for managing the peak. So, where is the role of storage in California? These are some of the applications that came out of our research findings, and a lot of these play into California and we tried to look at applications where you could try to understand the business case, and understand where is the cost of storage to serve a problem in these applications, and how do you go about stitching the various benefits together. And I'll be talking about that a little later in the second panel today.

Much of the work that I'm talking about today is in a public White Paper that is out there, I encourage you to look at that, it gets into the current landscape of where energy storage is in the U.S., many of the applications and demonstration projects that we just heard about, that are underway. And also, looking at these applications and how do you value them, and we've tried to lay out a transparent framework and methodology for trying to figure out how do we start to value storage. So, some general perspectives. You know, storage is challenging, there are options out here today that are, I would say, grid ready and can find their solutions, but many of the options we see really don't meet some of the technical and performance targets we'd like to see long term. So, our near term goal is to try to figure out what are these key applications, what are the functional and technical specifications for those applications, to try to shape products that can really meet these problem needs. We also need to test and validate that these things really work, you know, some of these are still coming out of the laboratory phase, some really haven't been used in Grid solutions. We're just starting to see, for example, you know, the application of lithium ion batteries, we've got them in our PC's and our laptops, they're starting to be deployed in some small Grid-scale, but they're also going to be deployed in larger Grid-scales, so we really need to get a confidence level. And so, what I think you're hearing from Imre's remarks and a lot of other activities that are going on across the country is utilities and various stakeholders are really testing these things, trying to see do they really provide the technical confidence for future business decisions. And then, long term, we've really got to keep the technology and the R&D pipeline going to really try to drive cost down, and I will come back to the volume vs. production question.

So, one of our questions, I think, in California, is really looking at where does storage fit, what are the application requirements for storage, and try to send some really good signals to the market and to developers to define and deliver products that meet these applications and serve these needs. So, the industry is trying to work through some functional requirements and technical requirements. I think we still have got a lot of work to do, particularly in the wind and PV integration area. So, what can be done?

And I'll go through these pretty quickly. Storage must be a complete product. Users don't want to have to integrate systems together, they want a complete functional system that's really Grid ready. So, as we think about advancing storage in California, we really need to be thinking about a complete integrated product that really can integrate with the Grid and has the communication control, etc., and is, obviously, safe, cost-effective, and reliable. Storage must be integrated with the Grid, not only the integration and infrastructure, but also within the regulatory and market framework. So, some recommendations. We need to figure out how to accelerate and enable a portfolio of solutions in California that are Grid ready, cost-effective, and safe and reliable, and to focus those options on products that really solve industry problems.

We need to establish clear targets for those applications, specify clearly what the storage systems have to do, again, test and validate, make sure that they're robust and they can lead to further deployment and procurement. We like to see more standardized products. What we see right now is a lot of one-off systems and I think productization will lead to cost reduction, which plays into the volume question.

We also need to understand Grid integration, this is more or less from the load serving entity perspective of how to accommodate distributed storage. I think in the wholesale arena, these are – we're talking about much larger assets that can play out much like an IPP project would play out, but I think there is still some grid integrations relative to how bulk storage deals with the ISOs in monetizing some of the ancillary services benefits and other benefits that are out there.

So, this is my last slide. So I'm sort of suggesting both a top down and a bottoms up approach. From the top down, it's good to hear we've got some studies underway in California as part of the long term power procurement plan, but we really need to do a really integrated supply transmission integrated analysis of how storage can support California's RPS needs. And this will help define the role, the location, the optimal mix of the storage, and how storage can be one of those solutions for flexibility. So, those analytics can help establish California's roadmap and lead to the more specific requirements and products. From the bottoms up, and we're working very closely with a lot of the distribution utilities, to start looking at how storage can be used on the grid, how it can be used to support increased penetration of photovoltaics, how it can be used as a one option for CapEx deferral of infrastructure and, again, another toolbox, distribution planning functions within that a utility can use to meet their reliability and service needs.

Finally, just a few other recommendations. Perhaps storage can serve as a bundled product. How to look at how fast response storage can provide higher quality megawatts than the tweaking or cycling of thermal fossil plants. You know, in some regions in the country, like in the Midwest, a lot of wind penetration really requires the coal units to really hit their minimum load and maybe even go down to shutdown conditions, which we want to avoid, look at storage as a solution or option in terms of demand side management, peak reduction and, again, deferral of infrastructure. Thank you. I would be happy to take any questions as I'm on the panel. Thank you.

CHAIRMAN WEISENMILLER: Thank you. Thank you for your contribution. I have a couple questions. The first question is, you talked about combining wind and storage, and I guess that gets to the basic issue of economies of scale, whether you basically try to do centralized storage to deal with this first wind, or whether you just disperse the wind and storage together.

Is that being done, any analysis of that?

MR. RASTLER: We have started and I'll talk a little bit about that a little bit later in the second panel, but it really varies. As you saw in the projects in Hawaii, those are sort of very close, it's part of a bundle, it's part of a purchase power agreement. In the U.S., we really haven't seen that happen yet, just because of the different ergonomics on the mainland. The Duke Notrees project, of which EPRI is going to be a part of, will start to look at that a little bit as it dispatches into the ERCOT market. We've been looking at compressed air energy storage as a wholesale asset that can address increased wind penetration and there, as a wholesale asset, it's just out there, but it really depends, again, on location. Can you site these assets where there is transmission congestion and use it as more of a wholesale asset.

CHAIRMAN WEISENMILLER: Okay, and earlier we talked about the three uses of storage and one of those dealing with the instance where something trips, or we lose a major unit, or a major transmission line. At this stage, is that anywhere close to economic? You know, basically we would be needing at least, say, 1,000 megawatts of storage, and you would have to obviously deal with the 10-minute requirement, and then be able to hold the load until you can re-dispatch something else.

MR. RASTLER: Generally, most of the storage options are limited energy duration. You've got obviously pumped hydro and compressed air, which could give you 10 to 20 hours or more, depending on the reservoir capability, but most of the other options are very limited in energy duration, mostly by economics. I mean, you could build more energy duration, but it becomes cost prohibitive, so we see a lot of needs for systems that are in the maybe four to six hour range for grid support, and then it was mentioned, the shorter duration options for the frequency regulation services.

CHAIRMAN WEISENMILLER: And is EPRI doing any R&D on sort of dealing with variable speed motors for the pump storage or for their poundage hydro?

MR. RASTLER: We're not, we're really not doing too much on pumped hydro at the moment. I should say we are working with DOE on a collaborative study to look at how existing pumped hydro is being dispatched, and I think one scenario is the WECC under the 30 percent RPS to see, you know, what can we learn from existing assets in the market, how are these assets dispatched, and how could they improve the use of the renewables? We're aware of the variable speed drive technology, but we're really not doing too much in that area right now. We think any new plants that get deployed, and there are over 15 or 20 permits out there across the country up for permitting, I think those will definitely consider the variable speed drive technology as part of their go forward.

CHAIRMAN WEISENMILLER: How about on relicensing of some of the hydro?

MR. RASTLER: We did some work a few years ago on relicensing hydro and I'm referring to the dam safety studies that we did, you know, how do we relicense these old plants? I'm not aware we're doing much in that area right now with pumped hydro, but I can get back to you. I share that responsibility with one of my other colleagues in the Renewables Program.

CHAIRMAN WEISENMILLER: I guess my last question, on the compressed air, obviously in California we're now very focused on some of the gas pipeline safety issues, and the question is, is anyone worried about that aspect of the compressed air storage projects and what the cycling might mean to the gas pipelines?

MR. RASTLER: The gas pipeline in a compressed air plant would be considered just as a pipeline for a combined cycle plant, so we're not too much worried about that. What we have been thinking about is underground caverns which depleted gas wells and what's the potential for a detonation or something if you have a mix of methane and oxygen in a cavern, and we’ve been doing research on that to understand the potential issues and how we might need to mitigate that. But it’s mostly around the underground cavern, but not the pipeline. I’m not aware of any issues that we should be thinking about there. It’s the same as a combined cycle plant or gas turbine feed.

CHAIRMAN WEISENMILLER: Good. Thank you.

MR. RASTLER: You’re welcome.

MR. GRAVELY: Anymore questions before we go on with the discussion? Okay, so what I’d like to do is expand on the questions here a little bit for the panel and hear from different members.

One question came up earlier today and this was really addressed in here about the ability define the role or how you implement storage, and from the panel I’d like to find out, if we implement storage going forward, or if we approach our policy and regulations as storage being a market service vs. a AB 32 approach, I mean, as an AB 2514 approach as a utility target, which one of those is the right way? Or which one of those would be more effective in getting the storage we need, what that number is, on the Grid in time for the future RPS requirements? So, the question would be, is it better to approach it going forward as a market, or better to approach it going forward as a utility requirement?

MR. ROTHLEDER: I think it's probably going to take a combination of both. Just as the existing conventional fleet, the market revenues themselves, daily energy balancing services may not be sufficient for revenue adequacy of the resources and you need other revenue streams to keep those resources viable and in service. And I think storage will probably be something similar where you have to do somewhat of a combination, where the market service is somewhat offset, the revenue stream requirements may not be sufficient.

MR. GRAVELY: Amanda, any comments?

MS. STEVENSON: Yeah, I agree with the combination use.

MR. RASTLER: I would also agree. I think – again, it's application specific. I think, in the wholesale area, something like a compressed air plant would be considered an IPP or it could be owned by a vertically integrated utility as a generation asset, so they're going to have to pencil out the business case and get the appropriate cost recovery. I think the cost recovery question is something that needs to be addressed and considered as part of – you know, if storage is going into support renewable integration, then maybe helping support transmission and cost recovery might need to be considered. It was considered in Texas for a project there in terms of the depreciation considerations. I think in the utility perspective, the regulated utilities want to evaluate these options as just and reasonable, and they also need a regulatory framework and a cost recovery mechanism to consider these as a business asset, as a utility asset. I would also suggest, we would like to encourage multiple business models and I think there could be some opportunities for independent power producers to provide services to regulated entities. Again, cost recovery considerations need to be considered in that.

MS. STEVENSON: I think I can further speak to that. In Texas, currently with the Legislature in session, we do have a storage bill that is now passed the Senate and an identical bill and it has passed the House, that we’ve tried to tackle this problem, but whether or not it should be generation or TDU owned. Currently, as the bill has swam through, we are considering it for right now generation in the sense that it can have all the same generation benefits and interconnection, and on an ad hoc basis the PUC of Texas can decide procurement from TDU, so not having it sit in one house or the other, TDUs can procure, it can be generation, storage is storage, use it for what it's for and don't pigeon-hole it, and I think whether in generation or TDU.

MR. GRAVELY: Okay. So what I'd like to do for the next 10 minutes is actually allow some people in the audience here to speak to this particular panel here and we're addressing the need of storage and, later, we'll be talking about the cost of activity and utility application. So, if there is someone in the audience who would like to come forward to the mic, is there a Stacey here, I guess? You can start and then we'll do about 10 minutes of this and then we'll wrap up the morning session.

MR. REINECCIUS: Thank you. I wanted to address one of the questions that the Chairman asked in regards to –

MR. GRAVELY: Would you identify yourself, please, for purpose of the people online?

MR. REINECCIUS: Oh, certainly. My name is Stacey Reineccius, I'm representing Light Sale Energy. We develop and sell isothermal compressed air energy storage systems and we're based in Oakland, California.

The question I have or point I wanted to make is to address the Chairman's question in regards to safety and gas safety with compressed air. New technologies, whether from my company, or from other companies such as SustainX which were mentioned in the DOE presentation, which are isothermal, are also referred to as non-fuel compressed air systems, that is that they do not use gas fuel to provide compressed air energy storage and, so, eliminate that issue. Thank you.

MR. GRAVELY: Thank you. Other questions? Okay, other questions from here? Anybody online, did you have any questions? Do you want to open it real quick for online to see if anybody has questions? Okay, so I took that as no questions. So, I would recommend, we have a very full afternoon, and maybe we could break early and return early, so I would recommend we leave now and return at 1:15 instead of 1:30 and that would give us a little extra time for the afternoon, and we have quite a few people who want to speak at the public session, and that will give us a little more time for the public session if you’re okay with that. Okay, we’ll break and reconvene at 1:15. Thanks.

(Break at 12:11 p.m.)

(Reconvene at 1:22 p.m.)

MS. KOROSEC: All right, everyone, we’re going to go ahead and get started now with the afternoon session. And Mike Gravely is our Moderator for our first panel –

MR. GRAVELY: Or afternoon panel.

MS. KOROSEC: Well, yes.

MR. GRAVELY: So, good afternoon. So we have now this afternoon for us two panels which we're hoping to cover the information and have some time for discussions like we did before lunch with the panel members, and then there is time in the afternoon for questions. We do have people in the room that want to ask questions. If you haven't already, there is a blue card, give it to either Suzanne or Avtar, and we'll call you up to the mic to give your presentation or speak. We would just ask you to keep it to five minutes or less, just for purposes of all the people who want to speak. And also, we will do our best to talk about next steps and summarize what we've learned today at the end of the session. So, do you have any afternoon comments you'd like to make before we start?

CHAIRMAN WEISENMILLER: Well, again, welcome, thank you for your participation. Certainly looking forward to an interesting session this afternoon.

MR. GRAVELY: Okay, so two of our speakers are actually online and we'll just go down the agenda and, David, are you online?

MR. NEMTZOW: Yes, I am. Can you hear me?

MR. GRAVELY: Okay, so we'll do the same thing, we'll have Suzanne flip the charts for you here and, again, go ahead. We're going to talk about topics close to everybody's heart this morning, and that's cost and benefits and revenue, both in a perspective of what are the challenges, give us an idea of where we are today, and I'm sure you'll get some challenging questions from our Commissioners. Go ahead.

MR. NEMTZOW: Good. Thank you, Mike. And thank you, Commissioners. Ice Energy very much appreciates that you're holding this workshop today on the IEPR and that you've asked us on behalf of ourselves and the California Energy Storage Alliance to speak today.

I do have the problem here after the morning, I heard a lot of great panelists, and the saying goes, "Everything has been said," but not everybody has said it, and so rather than repeat the value proposition for storage, I'd like to just try to integrate that into a couple of key points I'd like to make about how do we quantify and how do we analyze the value streams of storage, so that the utilities and energy end users can make informed rational decisions that will serve California and its ratepayer and the power Grid effectively. So, that's the issues I'd like to tackle.

Again, Ice Energy, as you may know, is a – if you can flip to the next slide – we're a distributed thermal storage company. We make – our product is called the Ice Bear if you look at the picture on the top left. The Ice Bear is a water-based thermal storage that connects to regular traditional air-conditioning units, five-ton through 20-ton, and whether they're on the rooftop of a building, or behind on a cement pad at the district mall, it's all the same to us, and we can then run that air-conditioning unit using our real time controller, the cool data controller, which is very sophisticated, Smart Grid enabled resource, to run those air-conditioners at night when power is cheaper, when the Grid is less congested, when peak is much more manageable, and emissions are lower, and store that energy by day to peak shave.

The important point there is we are a distributed solution and some of the speakers earlier today talked about the role of distributed storage. That brings two advantages, one is that we are closer to the end user, and as a result we are very efficient, energy efficient, because we are near the end user we avoid the transmission and distribution congestion and losses that centralized resources have, and that's true for all distributed resources, certainly including distributed storage such as ours. And, too, as a thermal solution, that's particularly important; thermal is highly energy efficient, we believe we're the highest energy – sorry, most energy efficient storage resource out there and being distributed near the end user helps.

Now, there are some challenges with distributed storage, and that's why the controls are so important so that we can see, if you look at that picture on the bottom, we can aggregate our units and manage them as a single resource. In fact, as we speak, Ice Energy is working with SCPPA, the Southern California Public Power Authority, which represents the municipally owned utilities in Southern California. We are implementing a 53 megawatt distributed storage project using our technology, and 53 megawatts isn't a lot by pumped hydro standards, but for distributed storage, it's very sizeable and I want to emphasize the point that I know has been made earlier in other settings. Storage is well beyond research and development, we still, of course – storage and different technologies have different needs, additional research and support from the Energy Commission and the U.S. DOE and others, but many storage technologies from pumped hydro, which has been out there for a century, to technologies such as ours and many others, we heard earlier today from Amanda Stevenson at Xtreme Power that their battery technology and ours are in the field right now as we speak, and we're doing 53 megawatts in Southern California, and we're also engaged in some very serious conversations with Southern California Edison, and Northern California, and PG&E and others, again, for a resource that can be out there today and can be utility scale, as aggregated. So, if you can flip to the next slide, please.

So, if I can talk about the benefits and how do we quantify distributed energy storage, and I guess, recently, with the help of R.W. Beck, produced a modeling guide for – it focuses on our technology, but it's applicable to many others that are out there, how should a utility model it, and this doesn't make the policy case for it, it makes the practical modeling arguments. And that's what I'd like to talk about today. So, let me aggregate those three main benefit streams of distributed storage into, 1) improving utility system operations, and that includes energy efficiency, as well as Grid efficiency, certainly assisting power factor and voltage support, and of course improving the load shape; next are avoiding costs, and you pick them, there's a pretty long list of costs that storage can avoid, and of course, storage is not cost-free, but the costs that it can avoid are typically greater than the cost of the storage, and we can defer – storage can defer or avoid generators, especially peakers, can certainly avoid or defer transmission and distribution, and then for electric system losses, particularly at times of congestion, when losses are higher because of the congestion, so at peak times those losses are higher. If I could add, parenthetically, but importantly, one of the most important factors in valuing storage is not looking at averages. In the storage business, especially folks like us who have a peak oriented solution, and we know that California's Grid is plagued by peak problems, and it's a problem that's getting worse and not better with the prevalence of air-conditioning, and our industry, let's just acknowledge it, through no fault of anybody's, our industry operates at lower than a 50 percent capacity factor, there are very few, if any industries in America, that operate effectively without inventory and are operating in the 40's for load factor, and that's getting worse over time, not better, primarily due to air-conditioning. And that's something that storage can help ameliorate.

So that's part of trying to avoid that cost, which is very hard to quantify, that's an important factor here. And then, finally, the final category is that storage can enhance the capacity of the system and provide ancillary benefits, regulation, help integrate renewables which, of course, is the focus of today's work and others, and help make the Grid smarter and help it deal with outages and other problems. You could move to the next slide, please.

Let me just talk briefly about air-conditioning and thermal-based solutions, which are a subset of storage, of course, and that is to say – if I could just say it simply, and in bright red here, and bright green, everything in the utility system works better by night than by day, and I say that for two reasons, one is that, at night it's less congested, and we're away from peak, especially in a place like California, but also at night the ambient temperatures are cooler and things work better. And we all know that power plants don't do as well under high temperatures or elevation, we can't do much about elevation, and same for everything all the way through to the air-conditioning systems. So, if you aggregate those things, if you look at the columns now, not the rows, generation is more efficient at nighttime because of the cooler temperatures and the ability to not go all the way out on the fleet, not have to rely on the highest heat rate, most polluting, least efficient plants, but instead go for the better performing ones, those are available at night. Transmission, again, works better when it's not congested. Distribution, lower losses, and air-conditioning, quite simply, it's easier to cool night time air than day time air, and if you aggregate this altogether, you can see the energy efficiency, the energy performance, and therefore the efficiency, can be 50 percent better using thermal storage such as ours, or any of the other products that are out there, and I know that's near and dear to the charge of the Energy Commission of the State of California. Next slide, please.

So, let's look at the cost. I like to make one key point here, and that is this, there are many costs and avoided costs, and therefore benefits that distributed storage can provide, and all storage can provide, and they are not – you've heard it discussed all day, there's not one simple solution here, there's not one simple mathematical calculation. One person, one utility person we work with described them as pancakes. He said, "When we look at storage, we look at the pancakes, a value that storage provides, and we stack up those pancakes." And that, I think, is a good metaphor. And that makes the job a little harder, especially because it's newer to regulators and utilities and others. But that's the key here, is to look at all the value streams, and each system will be a little different, each utility has different needs, and users will vary and the storage technologies will vary. But the concepts are the same. And so, when I go through this list, I don’t mean to suggest that any one storage product – not ISIS, not any one provide all of these benefits, all these pancakes of value. But what we need to do as a whole is to go through this list and say, “Where are the values and how big are they?” And some we will not be able to quantify, at least not yet, but that doesn’t mean that they’re zero, and that does not mean that they should be neglected, so we will do collectively the best we can, and I think the CEC has a key role in that. So, again, some of these I’ve discussed earlier – avoiding capital facilities, namely generation, T&D that can be deferred or avoided as we flatten the peak, and we can peak shift. And I’m in Southern California and, as we know, anybody who wants to try to build a peaking power plant in the L.A. Basin can try to do so, but it’s becoming increasingly difficult, never mind the T&D challenges there. The reduced energy costs, in addition to reducing the energy from not having to rely on inefficient, high heat rate power plants, as well as the T&D losses. We also have one benefit that’s very hard to quantify, and that is the ability to avoid volatility. And at daytime, when the system is at peak, there's greater volatility, and greater risk from that in case there's extreme temperature, or some other extreme peak event at nighttime, we can avoid that, and that is a cost reduction. And that may or may not show up in the marketplace. Earlier, we saw a graph from Xtreme Power that showed the emissions benefits in California of nighttime generation vs. daytime generation, and it's quite significant. That slide used SoCal Edison data and San Diego Gas & Electric, and a recent filing at the PUC showed even more Xtreme data in terms of the day and night differential on CO_2 production.

MR. GRAVELY: But, Dave, would you wrap it up here a little? We're running over a little bit and we have several more speakers.

MR. NEMTZOW: Yep. Going down the list here, I think we've discussed them. Let me do this, let me skip two slides to that one. In this, the point I'd like to make here, and the point that's important, is, again, if you look at these different layers of value, if you look at all the values that storage can provide by shifting consumption, it adds up to very significant numbers. This is not, again, this is not the case in all cases, but this is accurate for Southern California, that the value of storage measured in megawatts, once you avoid the whole congestion on the Grid, can be 78 percent in this case, higher than just looking at the end use. And that’s the total benefit. And then, the same is true in T&D – if you can go to the last slide – and just, the most important thing that I would respectfully ask of the Commission is the following, 1) obviously you’re tackling the issue with today’s workshop of how to think about cost effectiveness and how to develop a methodology and how to encourage utilities to do that, and how to integrate renewables, but the one thing I’d like to say is prices, no matter how important prices are, prices will not be able to capture the value of storage anymore than prices capture the value of any other DSM, I mean, that’s why you’re in the appliance standard business, because prices are useful, but don’t wholly capture the value to society, so utility ownership will be a big part of storage. We think you should encourage that and allow them to be able to make informed decisions that allow them to look at storage as they do other resources, and towards that end, I would just encourage you – I know this is part of what you do already, but just as the value is spread out, the need for the Energy Commission and the Public Utilities Commission, the ISO, the utilities and others to work together on storage is essential because the value is so spread out over so many different areas of responsibility, you need to be able to aggregate those up on the policy level, not just on an analytical level. So, thank you again for the opportunity to talk about distributed storage.

MR. GRAVELY: Okay, so hang on in case there are questions at the end for the panel. So we'll now shift to Dave Hawkins from KEMA, who is going to talk to us about some studies he's been involved with.

MR. HAWKINS: Thank you very much. I'm going to skip right on to talking about the energy storage technologies. And let me say, first of all, that although a lot of my material shows costs for batteries and is sort of battery-centric, that's really not where we are at; there are a variety of storage technologies, including thermal storage, combined with for concentrated solar plants, there's thermal ice storage, as we just heard, there's pumped storage plants, as I've been reminded by my friends in the audience, and so there's a variety of different technologies that are available for this, and costs and so forth for each of them are unique to their area.

One of the things that was asked to comment on is, well, how much does this stuff cost, and everybody says, “Well, it’s expensive,” right? Well, at the current time, the prices tend to come in somewhere over $1,000, typically $1,500 to as high as $4,000, depending on the particular technologies. The goal has been to try to drive the price down to about $500 or $600 a kilowatt, and this has been the focus for a lot of the DOE ARPA-E projects to get to the next generation of technologies, so that you can get some of the costs down. As Mr. Gravely has so kindly reminded me, that it’s not just the cost for the bucket of energy, but it’s also the system cost and the inverters, and the inverter technology hasn’t moved a lot in the last five years, it’s gotten more efficient, but it is a significant component of all the overall cost. And also, you have the same thing of site integration and the computer systems to make all this work. The advantages, of course, is the inverters are getting better and, of course, the cost of the battery technologies and so forth, storage technologies, for some of them is coming down, not for all. Again, as my friends with the thermal storage say, okay, I just have to build a bigger bucket, and it doesn’t cost a lot to add more volt and salt, but if I’m going to add more lithium ion cells, it does go up sort of linearly with the number of cells. And if you’re doing flywheels, the more flywheel modules you add, the cost tends to go up in a kind of linear rate. If you're doing flow based batteries, again, you can make the tank bigger and the cost of the electrolyte doesn't go up as fast. So there were a variety of different technologies, not all of them the cost curves will go up the same way.

Lots of different varieties of storage technologies and the studies that we've done with KEMA, with the modeling studies that we've done, shows that the type of variability that you have to deal with on a system Grid level, you tend to have to have a device that is a two-hour or larger type device. And there are those who argue very strongly for the 15-minute device, that's all you need for the frequency regulation, but if you really – and you could go after that small niche that is a niche, and it is an important one, but if you really want to build out a system that's going to provide a two or three or four streams of revenue for you for making the cost of that energy storage device come together, you probably have to have at least a two-hour or longer device. If you're going to play in the ISO markets, yes, they do have the new rim one and it's going to be there, but, again, in order to make – at least when we've run the models, to make it pay off, you need something more than a couple hours worth of storage, and if you want to bid into day ahead markets and you want to do some of these arbitrage things, at least a bucket that is a couple of hours makes a big difference.

One of the things we haven’t heard very much about here today is the T&D efforts, or the cost of having this as a utility-based device. We’d like to see more discussion, I think, of the value for reliability, voltage control, things that are providing voltage support, reduced flicker, the things that you’re going to have with a lot more PV. So, if we have 3,000 megawatts of PV coming on as the target behind the customer meter, and 9,000 megawatts in the future spread throughout the distribution system on the utility side of the meter, there’s a lot of different things that can be done, and it’s very difficult at this point to show the market value of those because they’re not market-based, they’re basically Grid reliability-based. And so there’s new models that need to be created, new tools that develop to come out with an optimization of those, and we still have research to do that uses the synchrophasor PMU-type data to do the burst of energy for Grid stability, and also simulate some of these system inertia that you can get with these new type of techniques. Again, it’s going to be a challenge to show the value of those and to monetize that value because they do not have the same as a market-base value. If you look at the market-base value, that’s a lot easier, all you have to do is pull down the ISO’s Oasis data and you can run all the mathematical models you want, looking at day-ahead markets, five-minute markets, regulation, run their regulation energy management model, and look to see how you find the road to riches using that type of data. The caution, of course, is same as your stockbroker tells you, the historical data is no guarantee of future profits. And, of course, what you really have to do is to take 2010, 2011 data, and say, “Gee, what are the prices going to look like in 2020, or 2015, or 2016?” And my guess is as good as your guess, probably, as to what those look like, but that’s what’s going to be interesting.

I thought we’d just show you a few pictures. If you take the recent day, this is April 14th, and look at doing it – looking at I’ve got a big bucket, I’m going to buy energy at the lowest cost, the lowest cost that day was probably about an average of $9.00, and I’m going to sell it back at $40.00, and that’s my energy arbitrage going into the day at market with my whatever energy storage device I have, and let’s assume a round-trip efficiency, and so I come out making, what, about

$92.00. Let's say I made an average of $100.00 and I'm going to do that 365 days out of the year, so let's see, I'm going to make $36,500 that year by doing price shifting back and forth in this particular size/amount of energy storage. It doesn't sound like quite the road to riches yet, but, you know, maybe we're on the road.

Next thing, if you look at the thing that's always exciting, is the five-minute real time energy market at the ISO and, again, this is from the – let's see, this was from the April 14th or April 12th, and we had seven price spikes that are $1,000 or above, and you says, "Wow!" But, if you look at the duration of those, it's basically like one, or two, or three, or five-minute intervals, and if you've got a very fast device, of course, you can hit that number and discharge as fast as you can for maybe 10-15 minutes, but it's probably still going to be difficult to make a whole lot of money, even if you bought the energy to begin with at zero, you probably can't discharge enough to make enough money for very long periods of time.

There are other periods, when we look back at July of last year, where we looked at significantly longer number of periods, up to 45-50 minutes sometimes, where the price stayed pretty high up in the $70-100 to $200 range, and those particular periods are in the summer, there was some pretty good money to be made.

Okay, the next thing, we’re going after the ancillary services, so I’m going to bid into the day-ahead market and I’m going to bid to do the regulation, and so, if you probably have looked at the ISO’s regulation market, previously, it used to be a long time ago about $30.00 a megawatt, it went down to $20.00, then to $18.00, and then down to about $11.00, and then down to about $8.00. Recently, it’s been coming up, the ISO is buying a lot more regulation, and the price has been going up, and so here is a day where it was the Reg up, it was $15.00, and Reg down was $9.00, except there was some numbers at the end of the day that were really spiked. But let’s say I was in the market and let’s say the average price was about $24.00 across that period, times 24 hours, so I could make almost $600.00 in the regulation market, and let’s say I took – or, let’s say the average was closer to $500.00 over that period, so it took $500.00 times 365 days, every day was like this, I could make about $20,000; again, it’s probably not the road to riches, but at least it’s a start.

So, I think that, as we looked at AB 2514, the issue is, okay, we’ve got to look at all of these things and the trick is going to be, if we put some of this storage in the distribution system, how do we also then have both T&D value and also can we bid it back into the market without driving the distribution system planner crazy, because of the volatility we’ve introduced back into the distribution grid. So, conclusions and trends, let’s see, certainly cost challenges going ahead and hopefully the target price for energy storage is coming down, and we’re going to have the magic solutions.

MR. GRAVELY: Do you want to ask questions now, or do you want to wait until the panel –

CHAIRMAN WEISENMILLER: I think let’s go to the end of the panel. Hopefully we’re not going to keep going back through avoided cost concepts, but certainly if anyone else wants to talk about it, let’s try to get through that fast.

MR. GRAVELY: Our next speaker is Dan Rastler from EPRI and it’s interesting, the charts you’ll see now, EPRI has the challenge sometimes of presenting numbers, no matter what number you put on the table, someone is not going to like it, but they do the best job I’ve seen in the industry so far of trying to come up with comparable prices for multiple technology, multi-applications, and try to do the best they can to be accurate, so they are showing us some numbers here, at least their estimates from their studies of what different technologies cost and what their value is.

Dan.

MR. RASTLER: Thanks, Mike, and thanks again for the invitation to share with you some of our research findings. Yeah, we do take a lot of heat sometimes of trying to objectively portray facts, but we’re always open to understanding, getting better data, and this work that I’m sharing with you is based on some benchmarking work that we’ve been doing the last couple of years, and it’s ongoing. Again, reference to this report where a lot of the storage benchmarking cost and value analysis is documented in detail, there is an executive summary that’s a short read of about 20 pages or so, and if you want the full read of 150 pages or so, get the full document.

I’d also like to acknowledge Eric Cutter who is here, who is at Energy Environmental Economics, who has been working with EPRI closely on this work and continues to work with us as to taking this work to the next level. So, we’ve been really trying to get our hands around what are the total installed costs of a fully Grid ready energy storage system, and these are some data that are out of the EPRI report that I referenced. And I just should say that these are today’s costs, and they’re very application specific, and they include what I would call mostly the all in cost of what a utility or an owner would have to bear, particularly with respect to the interconnection and getting it really Grid ready for the Grid.

And just a couple of takeaways on this. We are, you know, emphasizing a lot on our work at EPRI on compressed air energy storage, and when you look at the dollar per kilowatt, or the dollar per kilowatt-hour, which is a CapEx number, which is the dollar per kilowatt divided by hours, it’s one of the lower numbers we see out there when we look at the bulk supply options. That said, it still does have its challenges in earning revenue in the marketplace. We’ve also been trying to benchmark some other bulk storage options, even though we have above-ground compressed air, but what could 50 megawatt, five-hour systems look like, both in the near term and in the long term, in terms of some of the emerging technologies? This year, we’re going to be looking at a few other options that we didn’t get a chance to last year, sodium nickel chloride technology, which is very well near term, and then we’re also going to look at zinc chlorine and sodium ion technologies, which are a little bit more the emerging area.

Okay, so now turning a little bit to the revenue and cost benefit analysis, and we’ve been really looking at two different approaches. We've been applying this total cost recovery method, which tries to look at what is the value of storage in a specific application and trying to present value the various value streams, and kind of knit them together to come up with a value that is a proxy for what a total install cost device could be. It's also important to look at these options under a cost per delivered KWH basis, so they're taking into account CapEx, the round trip efficiency, as well as what is the cost to charge this system or, also, if it's a compressed air plant, what's the cost of natural gas. And, of course, you've got to also consider the ONAM [ph.] and life, and how many cycles do I get out of this system over its intended life. So, it's important to look at these projects with these type of metrics. Both are really needed to support the business case.

So we started out looking at these applications and trying to understand, well, what are these benefits really worth, and try to really quantify them, and this chart illustrates kind of a range across all the ISOs. We could probably dial this down for you for CAISO. But a couple of interesting things come out of this and, of course, Dave just went through a few of them, as well, in his last talk, but you'll see that – and we have been looking at this from a utility perspective, so things that jump out are what is the potential value of deferral of CapEx? So, we've got deferral of transmission investments, deferral of distribution investments, we've been looking at fast regulation, that's another one that stands out pretty significantly as you look at the numbers.

So we've been trying to look at how do you then look at an application and stitch these benefits together, and this is an illustration of an example of some work we did in the PJM market looking at a two-megawatt system, and on the left you're seeing a sort of traditional utility perspective and what some of the benefits kind of stack up to, target values are – read that as average U.S. 50 percentile. And you'll see that the costs are challenging. That's about a half a million dollars for a two-megawatt system, so that's about $250.00 per kilowatt hour. On the high side, that's about a million dollars -- or $500.00 a kilowatt hour.

Now, if you look at trying to stitch site-specific benefits together and bring it into play local capacity, regulation, perhaps deferral if you can get it, the economics can be quite more promising. So, we're encouraging consideration to look at ways in which these benefits can be better monetized and help make the business case.

So we looked at these 10 applications and, again, tried to look at the value, again, in terms of dollar per kilowatt hour of usable storage, and tried to map those into the various applications I showed earlier, and we’re finding that, at least there are a couple of ones that really stand out, it’s not surprising that frequency regulation can really pencil out itself today, probably without a lot of other stitching, but also from the utility perspective, Grid support, and particularly assets that can be moved around to support needs across the Grid in multiple years, and really capture multiple deferral investments, really look pretty interesting.

We’re moving this work this year together to really try to bring to the industry a tool that will be regulatory solid, to help them look at the business case. Again, we’ve also been looking at the leveled cost of storage across the various technologies, and again, this is that levelized cost for KWH delivered. And I won’t go through the details, but to give you a sense of where we see the ranges are, based on the current cost projections that we see.

Here’s just a sample of some of the more detailed look across the various ISOs, and this gives you a feeling for what the benefits really are and what the revenue streams are, and here we're looking at price arbitrage and system capacity, and voltage support, which really doesn't show up too much. But then – now, if you can start looking at regulation on top of that, that starts to look interesting, and then 15-minute regulation looks actually a little bit better.

So now let me just turn before I close to some other work we're doing to really look at how storage portfolios fit into the market, how they can really support wind integration, and what role storage plays in bringing on more wind. And we've been doing some very detailed granular modeling work with my friends here in the audience, LCG Consulting. We did ERCOT about a year ago, just recently did PGM, and the New York ISO markets, and these were, again, fairly low penetrations of wind when we think about what's planned for the future. But, again, this points to the kind of analysis I think California needs to do to really understand where you get the biggest bang for the buck, how does storage interplay with future transmission and capacity investments. And so we have been testing various portfolios and to try to understand what is the underlying economics, as well as how do these assets support wind integration. And to illustrate one example out of ERCOT – am I running out of time?

MR. GRAVELY: Thirty seconds.

MR. RASTLER: Thirty seconds, well, I'll let you read the details, but ERCOT is somewhat similar to California, although there is a little bit more coal in the mix. But here you'll see that compressed air does pencil out roughly around 10 percent IRR if we can get around – about $800 a kilowatt. Some of the other technologies are a little bit more challenging, but an important thing I should mention, too, distributed batteries, if you can locate these at – of course, ERCOT is a nodal market, if you can locate distributed storage at these high LMP zones, you can really get some pretty interesting system benefits. The LAES here is Liquid Air Energy Storage, I didn't have a chance to change the chart.

So, just to conclude with some recommendations to do similar types of analysis, look at the criteria for improving the system in terms of system benefit costs, producer and consumer benefits, and those other items. And I'll close with that and look forward to your questions. Thank you.

MR. GRAVELY: Okay, the next speaker is Doug Divine from Eagle Crest, so, again, we've covered the topics in general, so we would have a chance to talk about them, so just go ahead and summarize the examples you have, but also point out some of the specific challenges you're having for technologies as you present those, too. Thank you.

MR. DIVINE: Yeah, thanks to the Commissioners and the staff for allowing us to talk about energy storage, and I'm going to focus on bulk energy storage today. Real quickly, Eagle Crest, we're developing a 1,300 megawatt closed loop energy storage project 60 miles east of Palm Springs. We have energy storage capacity in excess of 23,000 megawatt hours, and expect to be fully licensed by the end of this year.

I'm going to talk quickly about the costs, the benefits, and revenues associated with, again, focusing on utility scale storage. Cost estimates, I think, for – I'll start with the second bullet here first – energy storage should be built when it is the lowest cost, or a low cost, long term solution. Cost estimates for energy storage that make sense, I think, in the Western United States, somewhere between $1,500 and $3,000 per KW for pump storage.

Now, the benefits. We've been through these benefits, I'm going to let you read these. I think the key point is from pump storage to alleviate, you know, again, there's with the new technologies on variable speed pumps, they have the ability to run them above where they essentially act as a large flywheel, so they can provide almost all those services that flywheel provides. In addition, with appropriate design, they can provide very fast ramp rates. There is a project in Europe that can ramp at essentially 25 megawatts per second, so extremely fast ramp rates.

Now, we've talked about, you know, part of the policy is, what are the revenue sources for utility scale grid storage. So, these are long assets. They have a 50-year life or more for a pump storage asset. Due to the nature of electric markets in California, U.S. financial markets, it's unlikely that the non-utility owner would construct a facility without either a partnership or a off-TAC agreement with either an investor-owned or a municipally-owned utility. So the revenue sources are either the utility ownership, some kind of contract storage agreement, or treatment or some of all the storage project as an advanced transmission asset and some form of cost recovery for at least a portion of it through the TAC.

I'm going to give you back some time, but you know, recommendations, again, looking at these, I'm going to start at the bottom and work up, I apologize for that. But I think what we're looking at with AB

2514 implementation, you know, in order to provide for variable energy integration and system reliability, we need to set some least regrets targets for utility scale storage that is cost-effective. The PUC needs to recognize that utility scale storage needs contract terms in order to be competitive out there, we need 20 to 25-year terms, given the size of these projects, there is economies of scale with pump storage, bigger is better, bigger is less expensive, and then, finally, I think that the Commission should look at some form of storage form of an NPR, so a way to calculate, you know, let’s figure out what is that cost bar looking forward, estimating the values of capacity, the values of the arbitrage value of energy, the ancillary services that we’ll need in a 2020 plus environment with 33 percent renewables, as well as the greenhouse gas issues, and then other site-specific issues. I think, by creating that landscape, I believe that there are technologies out there, case and pump storage, that are cost competitive today. Thanks, I appreciate the chance to talk to you.

MR. GRAVELY: So our next speaker is – Mike, are you online?

MR. KINTNER-MEYER: Yes.

MR. GRAVELY: Okay, so we’ll bring yours up and, again, if you could try to keep it around five minutes, we would appreciate it.

MR. KINTNER-MEYER: Yes, this will be short. We're switching gears here and looking at demand side resources to help mitigate some of the intermittency problems. We here at the laboratory have been working on Grid assembly appliances, Smart appliances for quite some time, and with the advent of – or emergence of electric vehicles, we're looking at how can electric vehicles be used as a grid asset, and as a resource to the Grid. Next slide.

With certain analysis, with collaboration of the Bonneville Power Administration, to look at stationary energy storage, but used this also to re-couch and reformulate the question of how many vehicles would it take to provide balancing services if the northwest power pool would increase its wind capacity from currently – from the 2008 values of 4.4 to 14.4 gigawatts. So, we looked at various technology options and derived first the new additional balancing requirements which you see here on the bottom right picture. If you filter it and you're looking at the faster cycle requirements, which we call intra-hour, with cycle ability of less than the one hour, it would amount to about 1.85 gigawatts of an increment, as well as a decrement, so fairly symmetric. Next slide.

So we were asking the question, given these new balancing requirements, how many vehicles would it take? And we're just in the process of finalizing the data, so, because the data are not quite finalized, I haven't presented them here, but I want to give you a flavor there, that the number of vehicles necessary to provide the entire – and that's the entire balancing requirements – and we're looking at some of the technical potential, not whether that's economic, but from a technical potential – it's a function of how large the battery is, as well as the availability of the vehicle to contribute the resources. That means, what is the charging infrastructure? And we differentiate it to two cases there, a case for home charging, and then a case for home and work, which basically means public charging stations and charging stations provided by the employer at parking lots.

What I can say is that, if you provide a charging capabilities, which we call a level one and level two charging, level two is 240 volts, usually limiting the current to 30 amps, sometimes 50 amps, so it's a transfer of about seven to 10 kilowatts vs. level one charging at the voltage of 120 volts, limiting by 15 amps, which transfers electricity less than two kilowatts, using that split 50-50 of that infrastructure, and if you provide abilities to charge at work, the vehicles necessary to provide the additional balancing is less than today's vehicle stock. So, what this is indicating is that there is a significant potential in the new emerging electric vehicle technology as part of the future portfolio of Grid flexible or flexible Grid asset that can be brought to bear. So how do you actually do it? Next slide, please.

So you're seeing here often regulation services associated with vehicle to Grid, which is basically the same concept as a stationary energy storage, you're just utilizing the vehicle and, rather than being mounted on a fixed foundation there, it's on four wheels. But you are charging it if you have over-generation, you're discharging it if you have under-generation. Next slide.

So, what we are calling vehicle to Grid or Smart Charging, would basically reduce this modulation that you saw in the vehicle to Grid, to only the charging mode, so it is a modulated charging based on over-frequent over-generation or under-generation. So we call it vehicle to Grid Half because it only provides half of the capacity to the Grid, so it can only go from zero load to full charging or full load, however, if you click one more time, I think there is a much better value proposition, although you only have half of the capacity value in vehicle to Grid, half a smart charging, the costs are much less. There's no interconnection gear necessary to the charging station, or your house, because you never turn your vehicle to a generator, and it also removes all the uncertainties regarding battery life reduction that currently all of the transportation battery manufacturers have. If you were to expose a vehicle battery to Grid cycling, you would void the warranty. So, you could bypass these by just doing Smart Charging, or what we call "Vehicle to Grid Half." Next slide.

We implemented this in a test vehicle that you see here, so we are actually doing it and performing this. We're doing this in a particular way where we sense the over-generation and under-generation by measuring the local frequency. So we can even provide frequency or frequency product without requiring communications from the Grid operator to the vehicle, just by measuring the frequency, very similar to a closed loop governor control on a generator. So, this is really tackling the balancing requirements, issues that Mark mentioned earlier this morning. As far as the consistent over-generation is concerned during low load conditions, this will most likely not work. Other incentives have to be brought to bear such as price signals that would be then communicated to the vehicle, to say this is non-opportune time to charge you, reduce your total electricity bill by charging during times when the electricity costs are low, or even negative.

So, in summary, I just want to indicate that we're looking at emerging technologies here that will provide potential services to a vexing problem with integrating renewable resources. And I think electric vehicles are such a good target, it will come fully loaded with electronics and the necessary additional control strategy to do what I'm just talking about, is minor in the cost. So it's a matter of how do we monetize the value, how do we present the value to the customer, and that is a challenge that needs to be addressed as we have discussed there with the larger energy storage equipment. So, that's my presentation.

MR. GRAVELY: Thank you very much, Michael. Thank you very much. The next presenter is John Bryan from Fleet Energy Company.

MR. BRYAN: I appreciate the invite from the Commission. John Bryan from Fleet Energy Company. We are a spin-out of the nation's largest fleet sales dealer, so we sell about a billion and a half vehicles per year to large fleets, FedEx, AT&T, think of them like that. My prior role was at Xcel Energy as a Program Manager for a one megawatt sodium sulfur battery vehicle to Grid component, and then Smart Grid City, as well, so components of Smart Grid City. We are a service provider, energy and large vehicles, so we already sell the vehicles, so we're going to own the batteries in them, retrofit as need be.

So, one of the misnomers in the industry is that we use the Prius as a point of reference at the uptake of electric vehicles. The Prius is a great vehicle, but it's a very small car and it's not really good for fleets. If you look at the commercial fleet business, 60 percent of every vehicle sold in the United States is actually a commercial vehicle, so most of those are heavy vehicles. Since they're fleets professionally managed, controlled locally, usually a centralized charging location and, on average, they go 32 miles per day, you can see the data and it's in the presentation and online, both, from the Department of Transportation.

If you took half those vehicles and made them electric or sold them in the near future, you're going to have a lot of gigawatt hours of energy storage sitting out there, you might as well use them in some form or another, especially if they're already electric vehicles and already communicated to, as the last presenter noted. That's 13 hours of storage for the grid, that's about half the fleet.

I don't need to go in too much of this, I'll just at least explain what it is, this is Northern State Power, Minnesota, from when I was at Xcel Energy, we basically took the existing wind and extrapolated it out to what 20-30 percent looks like, and those yellow lines are wind dipping into baseload, blue is coal and red is natural gas. So, if you start having significant problems, and we know we need to have a place to put it.

Just, in lieu of time, I won't go into details on this, the gist of it is, time of charging matters to the utility. The coincident peak matters when you do it, you need to be able to control these things, and tailpipe emissions vs. the upstream emissions from the generators matter, as well, depends on the time of day and what is your actually coming out of the plants, the generation plants as you're charging your vehicles.

This one, I find this one fascinating, this is a two-second, a 32,000 points of data, two-second signal from PGM for frequency regulation, it moves all over the place. The only reason why I have it up here is to point out is, as you're fluctuating your plants, trying to follow the signal, you should have them operating more efficiently, lower emissions, lower costs, lower operations and maintenance, by having something that is actually built to charge and discharge rapidly, like a battery of some sort.

Batteries are already everywhere. This is, again, I'm actually using the Prius, but the work that we did at Xcel Energy in the picture, there's almost five million Priuses out on the road, they've got a kilowatt-hour and a half battery, so there is already 7.4 gigawatt hours out there. We might as well use them. Yeah, we can't use these now, but the upcoming technology is that you get more and more of these implemented, electric vehicles implemented in the grid, we should use them. That cost is already in the vehicle, and there's an opportunity to use that as both transportation and as energy.

Last slide, but also a couple of issues from actually trying to project finance this, we have project financing. One of the issues that we run into is the lack of a defined contract, independent power producer -- purchase power agreements, standardizing those for energy storage specifically would be a huge boost to the banks to make them more comfortable, as we've already discussed earlier, the venture capital is – this is a big asset, it’s too much – it’s very difficult to do in venture capital.

The other item that I think was important to note is that the transportation and energy industries are in some ways very separate, but as electric vehicles come together, they’re going to be – communicating that vehicles could be an asset to the Grid and as a component of the utilities portfolio, makes the communication from actual implementation of project financing easier.

The last point that I had to make is that, since 60 percent of the vehicles out there are commercial of some format or another, these are your – these are entities, businesses and commercial entities that are used to spending capital to save costs. And they have a fairly short range, so I don’t want to incent anything, these vehicles are already coming out there for major fleets, we should be using them. And that’s all I had. Thank you.

MR. GRAVELY: Thank you very much. Our next presenter is Matt Stucky from Abengoa Solar.

MR. STUCKY: Before I start, I have a quick question. Does anybody in the audience have a laser pointer? I left mine at home and thought I could – okay, there you go, perfect. Good afternoon, my name is

Matt Stucky. I am a Manager in the Business Development Group with Abengoa Solar, and I appreciate the opportunity to present today. I see my role here today as that of an advocate and representative of the solar industry, and particularly the solar thermal developers such as Abengoa Solar, and would like to explain how the thermal energy storage can be easily integrated into thermal – solar thermal power plants, and how that can change the output of the shape of that power plant.

With that, I'm going to move and start with the schematic here, just to kind of show how this technology works. On the right-hand side, we have a steam turbine, and this is just a basic Rankine cycle, and where you put steam into the turbine, condense it after you're making power back into hot water, pump it back, and through a heat exchanger, make steam and keep the cycle going. So, at this point, you have a need for an input of thermal energy. This particular process flow diagram is showing a parabolic trough plant, so, to collect heat energy from sun, you can concentrate it using mirrors and, in this case, if you have trough-shaped mirrors, you can focus the sun's energy on a linear receiver, Running through that receiver, a heat transfer fluid, and the commercially used product is an oil that you can heat up to about 730 degrees, so coming out of the solar field, you have an oil at 730 degrees, you come through the heat exchanger, give up that heat to the steam cycle, and then come back around to the solar field and heat it again.

So, ignoring for a minute the storage component shown here, this is a standalone power plant. So, you can incorporate energy storage in the form of thermal energy storage into this system by using molten salt. Imagine that – there's a certain thermal input needed to operate this steam turbine, you can size the solar field to meet that heat input. Now, imagine you over-size the solar field and you now have additional heat that, in addition to running the steam turbine, you can also heat up a secondary fluid and, in this case, you can use molten salt, that's what we're showing here. So, moving this salt from a cold tank, cold in this case being 500 and something degrees Fahrenheit, over to a hot tank, you're heating it up to 700 and something degrees, and when you no longer have an incoming solar radiation, you can draw heat from this system to continue to run your turbine.

Now, this system is called an indirect thermal energy source system because the actual storage fluid is not the fluid that is being heated directly by the sun, we're indirectly heating it by first heating a heat transfer fluid.

Now, I want to also show a second kind of diagram for another kind of plant that has even greater potential for thermal energy storage, and this is a plant with a central receiver that you could mount at the top of a tower and, instead of having rows and rows of parabolic troughs, here you have relatively flat mirrors that would again collect energy that falls on a given area of the earth, focus it onto a central receiver, and the advantage of this system is that you can get rid of – this can be a direct thermal energy system – you can get rid of the intermediate fluid and heat thermal salt or molten salt directly, and the benefit there is that you can get the hot side hotter. And when you’re giving up this heat again to the Rankine cycle at the top of the diagram, for a given gallon of molten salt at this elevated temperature, you get much more heat out of it as you pass through this heat exchanger, and so, for the same volume of storage, you actually have much more thermal storage inherent in that. So, I just kind of wanted to show how the technology works, and then this graph demonstrates how you can basically change your output profile of a plant. In red, you have standard output profile for solar thermal plant, it looks a lot like the output for a PV plant; when the sun rises, you produce power, produce a peak capacity through the mid day, and then you drop off in the late afternoon. And when the sun sets, you’re not producing at all. If you were to integrate storage, if you were to over-size the system, the collection system, you can add hours of additional energy production capabilities and this is just one example of how you could continue to produce power when the sun goes down. Now, you could also store that heat energy overnight and increase and be producing power before the sun comes up; likewise, you could, really, the possibilities are limitless in terms of when you’re collecting energy from the sun, when the sun is up, but you’re producing power whenever you’re drawing it off of your heat storage.

Now, this graph is actually not really based off of any real exact data, but I use it just to illustrate a point and what’s possible with thermal energy storage. In the red, just imagine you have, I guess, a bundle of intermittent generation, such as PV and wind, so this is just showing how this could be variable throughout the day. Now, imagine that you have an oversized solar thermal plant, you could ramp, you could manipulate the output in the generator, up and down, to provide basically a mirror image of the output from some variable sources, so that the combination of the two is a straight baseload output profile. Now, it’s not exactly this easy, but I use this simply to demonstrate what’s possible in integrating thermal storage into these systems.

So, this is actually technology that’s not really pie in the sky, or a future, not something we have to wait decades to implement, but rather has been implemented over the last many years, starting SEGS I in the 1980’s here in California, the Solar Two Plant, which is the second one on the list, which is actually a molten salt storage plant that operated from about ’95 until ’99 in Daggett, California. We have in Spain, there are 50 megawatt plants with molten salt storage that are in operation right now, with multiple hours of storage. Gemasolar is a plant in Spain that is starting up right about now, as we speak, it’s a 17-watt central receiver tower that’s actually going to have 17 hours of storage, making it effectively a baseload plant. And then there’s Solana which is an Abengoa solar project in Arizona, which will be the single largest thermal energy storage project on the planet, once it’s built. It’s currently under construction.

And so, in the interest of time, I won’t go into this rather busy detailed slide, but I would like to kind of jump to some policy recommendations and, if we in the solar industry were to present ours asks on how to – or ask policymakers to allow and facilitate the implementation and development in California of these technologies, I think AB 2514 is a great start by setting targets for the procurement of thermal energy storage. One intriguing idea is to introduce time of day rules to the RPS System. By that, rather than accounting over the entire year, whether a utility is procuring a certain percentage of renewable resources, but rather break the day into periods, such that this is required every day, of every hour of the day. And, in addition to that, you could add a storage payment on top of the MPR for solar thermal projects, I mean, that’s one way to say it, and another way to say it is for utilities evaluating similar offers from renewable projects, if there is a renewable project that offers storage, in addition to being a renewable resource, that should be preferentially favored, I would say.

Since we’re being greedy and asking for, you know, the entire wish list would include something like the California version of the loan guarantee program, there’s a Federal version right now, the exemption of sales and use tax on energy storage components, I think, would certainly facilitate the implementation of this technology. There is a bill, AB 1376 that is working through the Legislature now, it's a partial sales tax exemption that would apply to storage components, expand and pass AB 1057, which is a manufacturing sales tax exemption, that could be expanded to include thermal storage equipment, and then I think the State of California can help by just lobbying and supporting at the Federal level the extension of the 1603 Program, which is basically grants for energy property in lieu of tax credits. There is also a tax credit that will revert to 10 percent in 2017. We would ask to make permanent the current status of 30 percent for that investment tax credit. And then make solar projects salable for private activity bonds. And all of these, as a whole, not only create a market for thermal energy storage, but also provide the incentives and overall lower the cost of financing. With that, I thank you.

MR. GRAVELY: Thank you. Our last speaker for this panel is to give us the ratepayer perspective, David Ashuckian from the Public Utilities Commission.

MR. ASHUCKIAN: Thank you very much. David Ashuckian. Although I work for the Public Utilities Commission, I'm the Deputy Director for the Division of Ratepayer Advocates, and we are an independent division within the Commission. We are under statutory mandate to advocate for low cost rates for utility customers, consistent with safe and reliable services. Our Director is actually appointed by the Governor, separate from the Commission. And we have our own separate budget.

I was asked to come and provide the ratepayer perspective and I was beginning to think that I was a little bit out of place, but given the last speaker’s wish list, I can respond to some of those as my presentation kind of addresses some of those issues. A lot of my slides are redundant from what we’ve heard today already, the background about the bill and the hearing that Michael talked about at the proceeding at the PUC, so I won’t talk about that.

We have, you know, as we heard today, there are all different types of storage and many different types of storage have many different applications, and certainly I’ll talk about some of those challenges that we will have to deal with because of that. But, again, I won’t go into the various technologies here, you heard about pretty much everything, I would think, so far today. you also heard about the many benefits they provide, we certainly agree with those, and certainly the fact that they can displace the need for other things that provide benefits and reduce costs, as well, so, again, I won’t go into these details. Again, I think you’ve gotten pretty much all of that already.

Again, the Bill, AB 2514, requires that storage be viable and cost-effective, and that’s where our input comes in. And certainly our role in advocating for the proper policies as they are developed by the PUC, is a main area for that. We certainly have looked at the Scoping Plan or Scoping Documents. The questions that the PUC is asking of parties in developing those plans, and some of the things that we have identified, is that we want to make sure that we’re not creating policies in order to fit the technology in; for example, time-of-use rates and dynamic pricing is one policy that we’re integrating and it’s been identified that, well, that type of pricing can actually favor the use of energy storage because it will shift people’s usage. If that’s actually true, we want to make sure that we’re not establishing a rate to fit storage in, but we’re creating a rate to make the whole system integrated better. So we want to make sure that the technologies fit the application, that we’re not making applications to fit the technology, basically.

The bottom line on our recommendations, a couple things that we’ve heard today that I think I would certainly endorse, that is that, you know, right now this is a policy driven activity, not a market driven activity, and that means that, in our minds, you know, we should make sure that we go at this slowly, we make sure that the technology and the policies that we're establishing fit the technology, and that it is cost-effective, that we look at how the costs and the benefits are achieved. I also saw in one of the early – I think it was EPRI's presentation – that we should deploy at the speed of total cost value; I think that's a great line and that goes to our next point, where sometimes when we see that we've established a mandate for a target, we tend to lose sight of the integration value and looking at the cost benefits of the program, and we just focus on achieving that target and that's one of the reasons why our recommendation is to hold back and not set a specific target. Certainly, continuing to look at applications and evaluate them as they are cost-effective and cost benefit.

And lastly, we need to always continue to compare the viability and the cost of storage with other options. Again, ratepayers are mandated essentially to pay for demand response, they're paying for energy efficiency, they're paying for smart meters that will facilitate the demand response, and now we're going to end up paying for renewables, they're paying for peaker plants, and dispatchable resources to back up the renewables, and now you're going to ask them to pay for storage to help back up the renewables that could offset the need for peakers. We have to integrate all these programs. Again, we often see that each individual program is trying to achieve its goal, but there's very little consideration of the integration between programs. We're still procuring fossil fuel generation in order to integrate renewables. If, in fact, energy storage comes online, we need to think about, okay, we can get by with less fossil fuel generation, but the folks who are in the business of procuring and building fossil fuel generation see this as, "Hey, we need…," you know, they make an argument for fossil fuel generation integrates the renewables. So, again, it's up to the policies to make sure that we're balancing all these competing and what I would call duplicative efforts that ultimately will only result in lower costs if we actually adjust various programs to accommodate the interlap and overlap between the various activities. And, again, one of our major jobs is evaluating requests that the utilities present to the Commission for revenue. Basically, they come to the Commission and say, "Do we want to ask for X millions of dollars to do a project?" It's our job to evaluate that request to see if it’s cost-effective, if it’s cost beneficial, how it integrates, and so we need to develop tools to accurate metrics to develop how various applications of different types of storage will be measured in this cost-effectiveness; because energy storage has such a diverse level of applications, it’s going to be difficult to figure out what does this actually result in the bottom line to the cost to the ratepayers, and what other programs will be back out or ramped down because we’re now doing this. And that’s, again, my main message. Thank you very much.

CHAIRMAN WEISENMILLER: Again, I would certainly like to thank Dave for coming and representing the PUC in this proceeding. We appreciate our fellow agency’s involvement as part of the dialogue.

MR. GRAVELY: So, I think there’s a chance for questions first and we’ll see if others – go ahead.

CHAIRMAN WEISENMILLER: Yeah, I think actually I was just going to start off with an observation. We’ve had testimony from several groups today about the value of storage and I think people have to look at history a little bit, you know, in the context of PURPA, we really got into avoided cost, and the issue of what would the cost be but for the generator. And eventually there was at least a decade-long, if not much longer proceedings at the PUC, really getting into the nuts and bolts of what's the value of power and a lot of the discussion today used some of the say concepts. Certainly, none of the people making those discussions had ever been expert witnesses in those proceedings, at least not from my recollection. But it turned out to be very very controversial because, what's going on? The other interesting test, and I guess the end result of all that, was in 1890, the notion was to get away from the regulatory proceedings, try to go to liquid market indexes, and the prices, and use that as the basis for avoided cost, as opposed to computer model awards. And I think, similarly, if you look at the other use of that skill, was in project financing, due diligence for projects and, again, there was sort of a limited number of companies that were bankable in terms of the evaluations for that. I had one of them. But in that context, certainly in the merchant power era, people looked at the value of power and I remember that era – I first got the impression it was crumbling when we discovered one of the companies for a Texas power project had revised its projections and sort of concluded the project met all the covenant ratios; three months before it became operational, within three months, it was bankrupt. So, in terms of looking at why did the models do so poorly, you know, part of it was all these models assume sort of a perfect system, perfect system – sort of a prefect CAISO for the whole west, well, in fact, there’s lots of bilateral contracts, there’s lots of permits, there’s lots of, you know, most of the west is not in that framework, so there are lots of reasons why the real world is not even close to these models, and that’s one of the reasons why the simulations just turned out to be not bankable. And, again, coming out of that, the project finance community was looking more for liquid prices evolving, that if you had liquid markets and price strips, you might be comfortable financing something, but they weren’t going to be comfortable with anyone’s projections, really, going forward. And maybe they’d forgot, but, I mean, a lot of money was lost in that era. So, in terms of looking at storage, which is much much harder than the merchant plants were, because in a way, for storage, you’re looking at what’s on the margin, both in the low load periods and in the high load periods, and trying to compare those two – the marginal fractions and the value of power in those various points. And if you look at most of the production cost models, they do a very bad job estimating how storage is going to operate for pump storage. So, again, analytically, we're really trying to push the envelope here and I think we should all be pretty cautious about the results with, again, if there is a way we can actually get to liquid – very liquid prices in California, you can actually see what the value of power is off peak and on peak, you could get a much better sense of what storage makes sense than to try to get into the computer modeling games again. So, I mean, that's one of the uptakes I would have. So, the Energy Commission could spend years trying to come up with projections that people believe on the value of storage, but it's very difficult and I'm not sure we'd be very comfortable with the estimates. So I think, again, going forward and trying to figure out what is the right amount of storage, it's going to take a lot of creativity to get something credible on that area, and some of the parts of it that are interesting to look at, I thought the Abengoa thing was interesting. One of the questions is, on the procurement process now, there's been a real shift from solar thermal over to PV, but if you look at the characteristics, obviously, for PV, you've got much more volatility on the output than you would on solar thermal, even without storage. So, again, at some point we have to struggle on how do we get those types of characteristics reflected in the procurement process, so that, again, ratepayers are getting the best values and we're giving the best pricing signals going forward.

So, again, certain, you've certainly given us a lot of thought, but I think some of the issues being teed up are going to be very complicated, trying to figure out what is the value and what are the right amounts.

MR. GRAVELY: Okay, given the time, I think we'll go ahead and go to the last panel and hold the questions until the public session. Most of the speakers will be here for questions. Thank you all very much for your time, I appreciate it.

So if we could have the third panel come forward, we'll go through and hear the utility perspective, both from the public utility and the industrial-owned utilities, as well as the Public Utilities Commission, again, from the perspective of the utility being the ultimate customer for storage when the purpose of the storage is to support utility Grid integration. The first speaker is Mark from Southern California Edison and he'll give us the Edison view on storage.

MR. IRWIN: Great, thanks for that and I appreciate you inviting Edison to talk today. It's been really interesting to hear different people’s viewpoints and I’ll try to quickly go through some of the things that we’re repeating and also try to attribute some of the phrases like “storage at the speed of value” to the U.C. San Diego and U.C.L.A. and Cal teams that coined such a fantastic phrase.

So, that really leads me to the first slide that we talked about and, so, people have talked to you about applications, they’ve talked about operational needs, and storage at the speed of value really comes back to that, is you need an application to create a value. And so Edison’s approach to storage has been to look at it on an application basis, to look at those applications throughout the system from clear down on the distribution system very close to the home, all the way into grid-based storage. We identified 12 applications and evaluated them all, some of them more promising than others, but did not find any to implement today. But we found things that we looked at actually initially how does it look today, and then we looked at what do you have to believe for it to be economic. And we saw, actually, a lot of promising things. And I’ll talk later about the public information we’ve provided recently on that and some of the other things we’ve done. So we start out, you know, storage at the speed of value -- thanks, Byron –- application-based storage. So the next question is, you know, how is energy storage from the utilities perspective different than from the market perspective? And who should own storage? And those two things really kind of go hand in hand. So, when somebody asks me, should the utilities own storage, my answer is not always as helpful as people like, "Well, it depends. What's the application we're doing?" So, if we're doing something on our distribution system that's integral to the reliability of our distribution system, we're deferring a distribution system asset build, it seems pretty straightforward that the utility needs to own that to be able to provide a reliable service. So, when it's a reliability-based type of application, it seems to make a lot of sense that the utility would own it. If we move to the other end of the spectrum where we get to a grid only based application, also similar to the way we've looked at power generation for a long time, grid only application would make sense to have either an independent party own it, or the utility own it, we've seen that application different across. But the challenge that that latter structure of market only has, that I think a lot of people have actually identified today, and a couple of other folks have talked about, is that's a challenging bar to reach.

One of the things we see in these 12 different applications is there will be some opportunities where what we call, and other people have called – I heard “stacking pancakes,” I heard “multiple cases,” we call it “stacking use cases,” so we think those are actually going to be some of the more promising opportunities for implementation. And then, again, when we’re back stacking into use cases, some of those are integral to reliability, that kind of feeds back into, well, who needs doughnut and who doesn’t need doughnut, and so, again, when we’re reliability-based issues, again, we have a view about the utility really being the right person.

So the other thing that I like, I like it when other people think the same as we do, so Byron, I have some more things for you guys that I’m happy with. R&D. You know, one of the things that, for a utility to integrate assets into its system, you guys have heard today lots of people saying these things are proven today, you’ve heard DOE talk about all the different ARRA funded projects that are out there. Okay, a utility isn’t interested in deploying assets into its Grid for reliability purposes that it’s never tested on its system before, that it’s never integrated into its system. So, this slide we have here talks about the things Southern California Edison is doing today to make that happen. Somebody said they had the biggest battery project in the Duke project down there, and it’s a 36 megawatt project, but it’s a 24 megawatt-hour battery; we should have made a bigger inverter so we could have said, “Our 32 megawatt-hour battery has more capability, but we didn’t size it for that super fast response, large volume, we sized it for a longer duration charge/discharge.” So, we’re building that battery in the Tehachapi system. It’s at a location that has both Grid and reliability opportunities, that’s why we selected that area, it’s an area on the 66th KV system up there that historically has had some level of wind curtailments, particularly in some particular n-1 conditions, so we have 12 specific uses we’re going to demonstrate, we’re going to demonstrate them each individually, and then we’re going to stack them and run them together. We haven’t yet worked all the way through the prioritization of which usages will come first. My sense, based on the organization I work for is the reliability will always be number 1, which quite frankly for this location makes sense, and then we’ll see how much of the value can we get from the other uses. We won’t get 100 percent because reliability will always come first.

So this project we're implementing, we expect to be in construction and on line in late 2012, and to have a two-year demonstration period. So we're really excited about being able to bring more data to this. The other things we're doing, which are kind of interesting, we don't kind of stop at the batteries, again, we talked about 12 applications. In our Irvine Smart Grid project, we have you could say four different battery implementations, I'll start with the easiest one which is Battery in the Home, and we're going to have a home-based battery, we're doing a lot of other things in the homes, we're putting PV on the roof, we're doing energy efficiency things, depending on different levels we're demonstrating, we've got eight different major demonstration pieces of our Irvine project, but one of them is a home battery in two groups of homes and we're going to give the homeowner the opportunity to decide what they do with that battery at times and we're going to take the opportunity also during times to decide how we charge and discharge that battery with their solar facility that they're installing.

And this looks a lot like the car implementation people talked about earlier, you know, Home Battery has a lot of the same constituencies, it's a small battery out on the system that we’re trying to access. The other thing we’re doing, and I think there was in the DOE project description Community Energy Storage that AEP has a project, ours is embedded within our bigger project, we’re doing it on one distribution transformer for a group of six to eight homes, that’s one of our community energy storage applications. The other one is we’re building a solar car shade so it’ll be a car shade on the top of a parking garage, with PV on the top, a battery charging facility, 20 stalls for cars to come in and charge when they want to try to understand people’s behavior when they don’t have a cost associated with charging, and how much will it get used, can we minimize the impact on the Grid of that.

Then, finally, we’re putting a larger transportable battery onto our system. When you think about transportable, I always think about mobile homes, they’re not really transportable, but they are. This is a container-sized facility, you know, we can move it, get it on a truck, take it off with a crane, so it works, it works a little better than a mobile home does. But we’re doing two things, actually, with that battery, a couple of different interesting applications, some of them have been discussed today, one is to look at, you know, when we talked about demand response being a potential opportunity to displace the need for us much storage, we are going to use the battery to send signals to the Grid. People also talked about PMUs and communication, things off of the advanced meters, we're trying to see how large the signal has to be for our grid substation to understand that that's happened, so we're trying to figure out what's the – is it a megawatt? Is it 40 kilowatts? Is it 50 kilowatts? So we've got a two megawatt battery, half megawatt-hour, or 500 kilowatt-hour, that we can charge and discharge two megawatts at a time, so we can swing a load of four megawatts to see what signal gets all the way through, so we're both testing the battery on the system, but we're also testing the DR and what communication we can get with the system.

The final application that that same battery does, potentially, is to unload a feeder that's getting really hot during the summer, so if we have a particular feeder, again, if you think about people putting a bunch of electric vehicles out on our system, on to feeders that were designed for the number of houses, not the houses plus a car in half of them, one of the ways we may end up deferring capital investment might be to put a battery out there to be able to get overheating off of our system and overloading off of our system. So, again, we're talking about all these use applications. We're out demonstrating it. This project will be on line in 2013 in a two-year demonstration.

Okay, so what are the key issues about storage going forward? I think, you know, the big issue for us, as I started out, is about let's look at the applications, let's look at what we need, let's support the ISO in their evaluation of what the system needs, let's figure out what the asset is we need. We'll figure out on the distribution system, on the transmission system, once we've proven the capabilities of these assets, we'll figure the value that we can get down there, and let's try to plug them together, figure out what is the most efficient way to do it, it might be storage, it might be demand response, it might be -- more likely, it's some of both, but that's what we're hopeful is people will have a good conversation going through this, take advantage of the R&D work that's going on, and take advantage of the ISO study work. So, that's it. Oh, sorry, one last thing, we've done a little bit of work on this, we published a White Paper a little while ago, it's on our website, we did that work last year, and then we got a Storage 101, a little bit easier, an eight-page pamphlet that we've got available. Our website location for the White Paper is referenced here.

CHAIRMAN WEISENMILLER: Thanks. Why don't you submit those for the docket, too?

MR. GRAVELY: Thank you very much. Can we hear from PG&E, Antonio?

MR. ALVAREZ: First of all, thanks for inviting me to participate in this discussion about the utilities view of energy storage. I'm Antonio Alvarez and I'm responsible for the Renewable Integration at PG&E. What that means is, over the last year or two, I've been very involved in the integration studies that the ISO has been doing to make 33 percent RPS feasible. How we approach storage, we approach it just like pretty much any other resource need, and we first try to identify what is the need, what is the problem we're trying to solve. And then, reflecting on the current integration study, we try to identify the need in terms of the amounts, the type, the operating characteristics required for the resources or supply or demand side resources that are capable of providing those requirements, and then see how much of those requirements can be provided by the existing system. You know, there may be modifications that can be made to the existing system to make it more flexible.

We know that, as we add wind and solar

generation, we're going to require the system to be more flexible than it is today. Well, some of that flexibility can come from the existing system, some can come from storage, additional demand response, and other flexible resources. So, once we have identified that need, the residential need, then we select the best mix of resources that can be used to meet that need and we do that generally through a competitive solicitation, where it is basically technology and we look at both demand and supply and try to figure out which is the one that gives customers the best value.

Just going down to the recommendations on the three or four questions that were asked from this panel, 1) in terms of the role of storage, again, I suggest a road map that starts with the identification or need, and then a competitive process to select the resources that are needed, that are needed to satisfy those needs. In terms of ownership, you know, the real answer is it depends on how integrated storage is with the existing system. I can see, reflecting back on the first question that Commissioner Weisenmiller asked about, you know, whether we're looking at economies of scale as kind of the determination for whether the utilities should own, I can think perhaps of a couple of examples, 1) the Grid reliability example that was mentioned by

Southern California Edison is perhaps one that should be owned by the utility; the other one that I can think of is a pump storage application where the resource is part of the same system where the utility operates, you know, different power plants under a common FERC license, that seems to me like an application where the utility ownership would be applicable, or appropriate. Others in the bulk system, again, it depends on whether the utility or third parties could offer a better value to the consumer. And that usually is determined through our competitive process.

In terms of AB 2514, we are not in favor of set-asides. To us, what that means is that you have kind of an optimal solution, it requires kind of a special treatment of a resource in order to be selected, so we'd rather have a processing which the alternatives can be compared on equal footing, and then we select the one that best meets the need and provides the best value to the customer. That's pretty much all I have. Thank you.

MR. GRAVELY: Mike Turner, here from San Diego.

MR. TURNER: Good afternoon. My name is Mike Turner, I work for San Diego Gas & Electric Company. Thank you for allowing me to come up here today and share SDG&E's perspective on energy storage. Energy storage is not a single application or technology, it can be installed in various locations with multiple applications. Behind the meter, it can be used to manage customer loads, also be used to manage on-site generation and cost at specific locations. On the distribution system, it can be used to manage reliability. In the future state, it can be used to island or have customers stay in service in a micro-grid mode, even with upstream outages. On the transmission system, we can mange power flows and shift power from on-peak to off-peak, also maintaining power quality, mitigating intermittent renewable energy sources. On the generation system, we can provide energy arbitrage and also ancillary services.

Some of these applications may be better suited for market or commercial benefits, and some of them are better suited for operational benefits. The ownership of the energy storage devices for these different applications should depend on various factors, especially, we think, operational benefit, safety and reliability certainly being most important. Therefore, we think the utilities are certainly candidates for ownership at all these levels. We think that because the utilities are responsible for operating the distribution grid presently. Customers expect the distribution to be operated safely, efficiently, reliably, and with power quality. The utilities are currently responsible for operating the distribution system to comply with all of these parameters.

On the distribution system, we will install energy storage to address increasing penetration of PV and other distributed generation systems. We use energy storage to provide voltage regulation and frequency regulation, also to mitigate power intermittency and voltage flicker, and also defer capital upgrades. We're also looking at installing energy storage at the substation level in order to mitigate intermittency associated with larger, centrally located, renewable energy generators, and also to provide voltage and frequency regulation benefits.

Here's a real live example of some of the problems caused by intermittency associated with a large PV system near the end of a distribution feeder. The upper graph is a profile of the voltage, as well as current output of a large one megawatt PV system at the end of one of our distribution feeders, a 12 KV feeder down in San Diego. That shows the output basically for about one day of the output of that PV system.

The bottom graph shows a magnified view of about five minutes of that output, and you can see how, interesting, in that five-minute period, there's a lot of variability. And, of course, that variability is caused by clouds coming in and out of the region. And just in that five-minute period on the bottom graph there, you can see the clouds have come in and out about three times, and the point of this slide is to show that energy storage is needed in order to solve real operational problems, therefore, we need to install the storage in the right locations in order to effectively mitigate problems like this.

Currently, SDG&E is pursuing a number of energy storage projects in order to gain experience and begin to understand and address the benefits and the challenges associated with energy storage.

One large demonstration project we're currently installing is a micro-grid project. Our micro-grid project will employ a number of Smart Grid technologies such as feeder automation, bar management, advanced meter infrastructure, a local distribution management system, and also energy storage at three levels. We'll install it at the substation level, at the utility scale size, that will be about .5 megawatts to one megawatt, and we're looking at four to six hours of duration for that utility scale application. We're also looking at a distribution feeder application where it will be installed and interconnected to the secondary side of a line transformer, the size of that unit would be 25-50 kilowatts with about a two-hour duration. And the third application of energy storage in this project would be at residential units, home energy systems, and they would be sized about one to three kilowatts with perhaps a three-hour duration.

Our recommendations are to continue to install energy storage projects in order to continue to gain experience with these devices, and also experience with the required support equipment. We need to develop standard practices and working methods in order to be able to install and operate these energy systems safely. We need to work with manufacturers and integrators to develop product value. Importantly, we need to understand the need and the drivers for different applications of storage.

We do not think that targets are appropriate right now for energy storage because the impact of renewable energy sources are not yet defined. We don’t know exactly how much energy storage we’re going to need for specific amounts of renewable energy sources in various locations. Also, wide-scale deployment of storage technologies will be difficult because large scale production capabilities are still developing at this time. And also, as a result of that, energy storage systems are currently expensive. Therefore, we think that energy storage systems should continue to be assessed on a case-by-case basis. Thank you.

MR. GRAVELY: So we'll now shift to hearing from the Public Utilities perspective, and the first one will be Mark Rawson from SMUD.

MR. RAWSON: My name is Mark Rawson. I'm the Project Manager for Storage Research and Development at SMUD here in Sacramento. I'm going to give back some of your time because I don't want to be repeating a lot of what you've heard from some of my utility colleagues in some of the earlier discussion, because I agree with most of what they said about ownership issues and value of storage, etc.

You've already seen some of this information presented about what some of the drivers are, these are the drivers for SMUD, our sustainable energy goal to reduce our greenhouse gas emissions by 90 percent by 2050 is driving us to look at more renewables, which means more intermittent renewables, in our case. And with intermittency, we're looking to see if storage might be a mitigation strategy for us to do much higher penetrations of solar within our service territory.

So, you'll see here some consistency with the requirements in 2514 for the types of things that storage are supposed to try to address. This is just some data from SMUD’s situation with respect to intermittency of our wind resources and some of our solar projects, showing that storage may be an opportunity for us to help deal with intermittency of these types of renewables onto our system.

So, what is SMUD’s storage approach, presently? I like to describe it as a three-legged stool. The first leg is technology screening and evaluation. We do both internal assessments of storage technologies to understand, you know, are they ready yet for utility or customer deployment. We do participate quite actively in EPRI’s storage program as another resource for us to understand what’s happening with emerging storage technologies, and some of the work that has been presented earlier today is stuff that we benefit from in the technology assessment area.

The third leg of our program is demonstrating of the more promising technologies. I won’t go through all the different demonstration projects that SMUD has underway, I’ve provided them in this slide deck in the back, but it’s very comparable to the projects that have been presented by SCE and PG&E, and San Diego Gas & Electric. Deployments behind the meter with customer facilities that own photovoltaics, so looking at trying to firm that intermittent resource right at the customer’s facility, all the way up through the distribution system. We even have activities at SMUD all the way up to the bulk level. I would say the third leg of our program is more focused on the value piece of storage and I’ll spend just a couple seconds talking about this. Because there has been some discussion today about the many different applications and benefits that can be derived from storage, some of those benefits are better aligned for the utilities, some for the customer, and in some cases they can apply for both the customer and the utility. and the question that we need to try to understand is how to quantify those benefits under different storage deployment scenarios because they’re not all mutually exclusive from one another.

So some of the work we did last year in our relationship with EPRI, basically used the approach that Dan Rastler presented this morning, but we drilled that down to four specific applications in SMUD’s service territory, looking at our voided cost structures. I won’t go through the details on this chart, other than to point out that, in our particular situation, we seem to be gravitating toward storage technologies needing to get to about $400 per kilowatt hour price point before we'll start to see storage applications being cost-effective, at least for these four applications that we investigated. One of our projects that we're doing this year is a zinc-bromine flow battery system, it's very close to that point, but I would say that that is still an emerging technology and, in the whole spectrum of distributed storage research that we're doing, we believe that many of these technologies remain unproven in terms of what is the life of the technology, how durable is it, and how reliable will it be, and what is its ultimate cost going to be. And so, therefore, we advocate that there needs to continue to be research and development, and I think the Energy Commission's PIER Program, as well as the Department of Energy, for funding a lot of the demonstration projects that SMUD is involved in today, that are helping our utility and our customers understand not only the technologies, but all the issues around how do we integrate these technologies into our system, how do we see them, how do we operate them, and can we rely on them as an asset for the future?

I'll just close with a few recommendations. I'll focus on the bottom part of it, as it relates to the panel questions that you posted to us. I think, at this point, there are so many emerging storage technologies that we're seeing. In the last few years, it's amazing how rapid storage technology has been developing and I think this workshop today is an illustration of, now, the policies trying to catch up with the emergence of storage technology. But at the same time, I think there needs to be a pause to take a breath. The business models around storage technologies and the companies that are trying to develop these technologies also need time to develop. So, in that vein, I think there needs to be flexibility that we need to allow multiple ownership structures, whether it's utility-owned assets from a reliability standpoint, I agree with Edison's presentation on that point; whether it's customers trying to implement storage as a demand response strategy to deal with TMU pricing, what have you, we need to allow for business models that make that happen, as well. There needs to be flexibility to allow utilities to pick the right type of storage for whatever their need is, whether it's bulk renewables integration requiring bulk storage, all the way down to customer-sided storage to meet customer needs, or varied distributed renewables. We need to let the need dictate how we deploy storage and how utilities will own it.

The last point I'll make is I think we need to continue to focus on cost-effectiveness, of the benefits delivered. We shouldn’t be pursuing storage for storage sake, we should be pursuing it for the value that it provides, and that drives us to need to look at the applications that it could be used for, identify what the value of the application is, look for the storage technologies that meet the functional requirements of the application, and go from there. And with that, I’ll quit.

MR. GRAVELY: So while you’re doing that, we’ll bring up from Los Angeles Department of Water and Power, Mohammed Beshir.

MR. BESHIR: Good afternoon. Again, thank you for giving me the opportunity to come and discuss the storage issue from LADWP’s perspective, I just have a little presentation. Again, I guess all morning and part of the afternoon, many things have been said about storage, I think I do agree, this is emerging technology and, of course, at the end of the day, this could really be a game changer for the industry, definitely. But I believe there is some ways to go.

We were given three or four questions, I guess, that’s really what I’m going to limit my discussion, even though there is more to be said, I’m just going to focus on addressing some of those three questions.

The role of energy storage from LADWP’s

perspective, I'm going to be talking about, I guess, a market perspective, we heard many discussions earlier, and how energy storage, who should own it, I guess, is the second question, and the third question is on the AB 2514.

From LADWP's perspective, I guess we have activities on all aspects of the storage business, but I thought maybe what I didn't see discussed was really application of energy storage and LADWP does have one of the largest storage facilities in the country, I would say, and we have been using the facility to integrate our renewable resources. This Castaic facility is 1,200 megawatts, and the way we have been integrating the facility today, we have a project called Barren Ridge Renewable Transmission Project, as shown in the diagram on your slide, we have a project where we are increasing the capability of that transmission system, at the same time integrating that Castaic power plant, as well as some hydro facilities we have in the Owens Valley, into the large set of renewables we are developing in the Tehachapi and the High Desert Area, solar as well as wind, a large amount of wind and solar. We have done some testing and currently we do have 135 megawatts of wind integrated through that system, and we do expect that that renewable development will be much larger in the next few years, and we do see a lot of positive activities from the integration perspective. So, that’s one activity we are doing and I think the data and the work we are doing and the Castaic Pump Storage facility has been going through the modernization process for the last few years, we’ll continue to do that, putting new controls, new aspects of that pump surge facility, it definitely will help us integrate our renewables a lot more efficiently and effectively to the system.

Other aspects of renewable integration we have been doing may not be 100 percent related to storage, but I think is related to the activities where we have wind assets far away from our system, where we are bringing, using DC transmission line with dynamic scheduling capacity, to be able to bring those resources to Southern California, where we will maybe be able to integrate those resources more effectively using the pump storage facilities and whatever other things we have to the system. So that’s from the integration point of view. The ownership, definitely, we do feel, I guess, as was said earlier, if a measured component of it is reliability related, we do think, of course, a utility does need to have a lot of say and that’s really what the reservation would be from the technology considerations, also, but similar with how we have handled the renewable development, if any time there is tax incentives and what have you, as a municipality service, we have not been able – we cannot use tax incentives, so we have used some kinds of optional capabilities, what we could probably have a combination of ways of ownership, but I think this is pretty open as far as discussion in the future.

With AB 2514, this as we see from the application of that law to the municipal utility, we do plan to follow, of course, the steps. We'll go through the process. Obviously, as was said earlier, we don't really believe these have to be really mandates or targets going forward, the technology is evolving, there are many aspects to storage. I think when we start talking about mandates and targets, it does take away, I think, the creativity and the flexibility of what you want to do, especially when you are depending on technology for reliability purposes, I think you really have thinking you have to do behind those targets. That is my presentation. Thank you.

MR. GRAVELY: So our last speaker for this panel, and I guess the one that has the last word before the discussion, is Michael Colvin who will give us the PUC perspective on the utility approach.

MS. COLVIN: So, good afternoon. I'm privileged that I get to book-end the day, I guess. I'm going to try and do this relatively quickly because I know most people have been sitting a long time.

One of the things that I think we heard a lot throughout all the utilities is this idea of let's do an application approach, where does it make sense and, again, I want to echo back something I talked about earlier in the day, which was I think what we need to try and do is come up with the general policy statement and then identify within this application model, or application approach, what are the interesting barriers to entry, what are the interesting barriers to cost-benefit analysis that needs to happen? And it certainly, then, rolls back up. There can be multiple applications for one technology, or vice versa, multiple technologies can work in one application, and so we kind of just need to make certain that we kind of clearly identify the sandbox we're trying to play in here.

Something that I think is useful when we talk about identifying applications is saying, "Well, what else could also fix this problem" And this goes back to one of the themes that came up at the beginning of the day, of could something else that is in our loading order also work? Or, could something else work here, as well? Could we achieve these benefits only from storage? Or is there something else that might be able to do it? I'm going to give a couple of examples just to help with the thought exercise.

The first one is you've seen the very very scary graphs that have the people at the ISO, you know, shaking in their boots of, how do we integrate all this wind and could storage be playing a role? One of the things that I wanted to kind of throw out there as a through exercise was, in the 2011 solicitation guidance for the RPS, for the first time, we have room in there for economic curtailment, it was something that the utilities very hotly contested, that you really fought for, and a balance was struck there, but for the first time there was a value that will be put into a contract saying, "If you curtail, here is a number around it." Well, for me, that's a signal of saying, "Well, in that situation, or in that application, that might be a value stream that storage could capture." And that's just an example of here is a problem, here is a contract way that we might be able to fix it, and here is a price signal that might come around that might be a role for storage, or it might be a role just to curtail or do something else. And so that's one possibility, that's one way of thinking about something.

Another example, this is showing my bias of my roots of spending many years on CHP stuff, one thing that I'm certain everyone in the room knows, when you do distributed generation, at certain times there are large standby rates, and sometimes that can help product economics, sometimes it can kill it. Well, let's think again just as a thought example, what does a standby rate mean? Well, if the DG goes down, you are essentially paying for the Grid as a back-up. Well, should you maybe have a second stand-by? Or one, under that normal example, but if you have storage, isn't that acting as your own back-up? And if that is the case, do you maybe want to have a different stand-by rate? And would that be a situation again, the avoided stand-by rate, might be a way of creating a price signal in a storage application? It's not a perfect analogy, I grant you, but it is something that I think we want to start thinking about in that context. Again, two totally different examples, but our way of what I think we need to do to try and help identify opportunities using this application framework, they are very stylistic, I recognize.

Shifting a little bit to a concept of ownership models, I would say for the most part we are trying to be very agnostic and, just like we were trying to be very agnostic as to what storage technologies should be put onto the Grid, ownership models should be fairly agnostic, as well. I do want to agree with some of the comments that were made earlier that, depending on the application, the ownership model will very naturally fall out, but it doesn't have to be exclusive, so an end use customer, a third-party developer, the resource generator itself, the utility, somebody else, you know, don't know, could own just depending on the context. I think ultimately, and I'm probably channeling my new boss here, but the ownership model is going to come down to a question of financing. How do we get the storage to actually pencil out? Is the spot market going to work? Is a long term contract the only way to do this? Could a rate design do this in a smarter way? Again, not trying to advocate any one option, but I think the financing is going to dramatically influence how we decide the ownership models – and, again, it's going to be very application specific, and that's something I think we didn't really get into in the utility part of the conversation, but I think that's where the conversation ultimately is going to need to go.

I think my last slide on this topic, there were some questions about RDD&D. I think we've heard throughout the day about some of the great projects that came from the Stimulus funds, from ARRA, there are a variety of options that are out there of how we would have been able to leverage those monies and how we maybe continue to be able to leverage that data that we're going to get to figure out what is the problem that we're trying to fix. My last point here is not all storage, however, is 10 years away from commercialization and needing demonstration, some of it we've had for 20 years on our system, and is ready to pencil now. And so, as we're thinking about, well, what's the suite of what we want within the storage context, and as the utilities are looking at, well, how much storage do I want on my system, it seems to me a smart mix would be kind of a portfolio approach of, you know, some things that are available today, some things that are available a little bit longer, longer term, just like every kind of emerging technology. So, I know that's a simplistic point, but that's something else that I think we'll need to be thinking about as we give guidance to the utilities kind of in the long term. And with that, thank you.

CHAIRMAN WEISENMILLER: Thank you, again. I actually had a couple of things to follow-up on about that. So, the first question is for Edison, in a way. As you indicated, Edison made a very strong case of needing economic curtailment for the new resources –

MR. COLVIN: I don't think I specified Edison, alone, I think all three utilities made a very strong case –

CHAIRMAN WEISENMILLER: Now, but the flip side of that is they were, at the same time, making a very strong case for the need for storage for their system. So, again, having made that case, what are the numbers in terms of megawatts? You know? I mean, you can't both need economic curtailment which can make these things un-financeable, and not need more storage.

MR. IRWIN: So, I'm a little bit out of my element, but not as far as I might otherwise be. I'm in the Advanced Technology organization, but four months ago, I was in the Renewable Procurement organization, so I'm a little bit familiar with the issue. What we saw in, actually, I think it was one of the earlier presentations, it was really the driver for us for curtailment, it wasn't the, you know, $40.00 negative, $50.00 negative, it was that inter-hour $500.00 negative; actually, they showed the positive side, but we actually see the same negative side. And so, you know, we approached it to say operationally it makes no sense that we have a generator running, as an example, we pay $100 a megawatt-hour and yet we're having to pay $500.00 a megawatt hour to keep that online, so we're having a net negative $400 for taking that energy on. That was one issue. So that’s the first issue of wanting to curtail, is because it makes a lot of sense, even if we pay the generator. And then I think our second issue was, well, we should have the market price this risk to us because, in some circumstances, their view of that risk might be different than ours, and we shouldn’t just say, “Well, we’ll pay you if we do it,” we should say, “Well, what do you want us to pay you?” You know, do we get any hours free that we don’t have to pay for it? Or, do we get the firsts 50 hours? Do we get something like that? So those were really the arguments we made. I think we were probably the starting point, the spin-off for that. But I think it was really – it started with operationally it makes no sense not to be able to do this when the economics makes sense, and then the second thing was, let’s price it in the market. We gave people certainty, actually some contracts that I was involved in signing while I was still there have already been project financed with those types of terms, so it’s clearly financeable, you can put a box around it and finance it, and operationally it makes all the sense in the world.

CHAIRMAN WEISENMILLER: But is it 50? 500? A thousand? I mean, how many megawatts of storage would take care of the problem on the Edison system?

MR. IRWIN: Well, we didn’t actually – so, we don’t have system models looking out 20 years as to what the system is going to look like, but let me just throw a dynamic on what’s really created this problem for us was, on our system, we have a lot of – Edison has more renewable assets or renewable opportunities – better renewable source than the other utilities do, so we have San Diego buying assets from our system and PG&E buying assets for our system, so we could look at the curtailment that was going to occur because of the current topology of the system and the current generators, we actually probably say, in most cases, it’s zero. Okay? So we couldn’t predict it. But we would say, “If somebody else built there, without building additional upgrades, which the ISO process allows them to come in energy only, right, and not have to build a lot of system upgrades, then the whole curtailment risk was really unquantifiable. So, we’re moving towards being able to model things hourly and that, but you can still only deal with the topology that you know. And so that was really the big driver for us and that scenario was we couldn’t value it. We could guess, we could look at, you know, CRR values and things like that today, but under an ever changing dynamic, it was challenging.

CHAIRMAN WEISENMILLER: Okay, well, switching to Antonio for some questions, I guess the first one was PG&E was the only one who opposed the ISO's storage tariff, I don't know if you're the one to explain why, or whether you want to have some of your colleagues in the written comments explain?

MR. ALVAREZ: Submit that in written comments.

CHAIRMAN WEISENMILLER: Okay, because we definitely want to hear on that opposition. I think the other thing, again, I think I mentioned before, Rory gave a presentation at IEP in September on Storage, and I don't know if you had a chance to dig that up, but, anyway, in that presentation, I guess what I was going to – again, make things easy for you – what we'd like to do is have you submit that for the record here, and give people a chance to respond. Rory did a number of slides that tried to go through some of the technical characteristics, in terms of the ramp rates of different units, and also compared across some of the storage technologies and tried to draw the conclusion that, from his perspective, looking at ramp rates and technical capabilities, that the utility really needed, in terms of storage, the pumped storage and compressed air was going to be much more valuable to the system than some of the other technologies. And so, again, it was a technical comparison and I think people will find interesting and presumably provoke some comments. But certainly, if we can get that in the record and give people a chance to respond to that, that would be useful.

MR. ALVAREZ: We will be glad to submit that. You know, I call tell you from, thanks to my Blackberry, I was able to dig up some of the ramp rates, but not all, but I can tell you that our pump storage, you can get from minimum to max in five to 10 minutes, so it’s significantly higher than conventional fossil resources.

CHAIRMAN WEISENMILLER: You know, but that leads to the question of, obviously, Helms was designed and built in the ‘70s and doesn’t reflect any of the variable speed technology.

MR. ALVAREZ: Right, so you could probably do better than that, yes.

CHAIRMAN WEISENMILLER: Yeah, and I mean, so ultimately I think we would certainly be curious and, obviously, you have a lot of poundage hydro that was built probably 50-100 years ago, which certainly doesn’t reflect the variable speed. So, again, certainly it would be good to get on the record some of what PG&E might do in terms of revising its hydro system with the variable speed to, again, better integrate in renewables, you know, what the cost and benefits of that might be. Yeah, if you could provide that, that would be great.

I think the last question would be pretty much, again, in terms of your comments, it would be good to get any suggestions – this panel has or any other panels on our PIER program in terms of the R&D we've been doing on storage, in terms of what the high priority should be and what would make that useful from everyone's perspective, given obviously our budgets are much more limited, say, than the Department of Energy or EPRI's, in this area.

MR. ALVAREZ: Right. Right now, we don't quite know the size of the problem we're getting into in terms of not knowing exactly the need. I mean, the ISO has an estimate of need that we work with them, and, as Mark mentioned before, it's a function of the assumptions that you make, but you can see a range around that that could be pretty significant. So our approach to storage is we want to make sure that we have options by 2020 to be able to integrate the renewables we have.

CHAIRMAN WEISENMILLER: Because when people do look at Rory's package of slides, if you look at pages 9, 10, 11 and 12, certainly you get into some of the technical characteristics, it would be good to get people's comments on.

MR. RAWSON: I'd like to comment if I could. I think maybe I didn't make the point too explicit in my quick talk there, but you know, PIER is supporting some of SMUD's storage demonstration projects through cost share through some of our ARRA grants. I would characterize our storage demonstrations as trying to accomplish kind of three things, there is the storage technology itself and trying to understand how it operates, try to see how durable we think it's going to be, how reliable it's going to be, the third kind of area of research is, how do we connect it to our system? How do we give our operators the ability to see it and start to get them comfortable with being able to rely on that asset if they have to dispatch it? And then the third area of our research projects, if they're customer sited, is trying to understand how that storage system would affect how customers choose to use energy, for example, in a demand response type environment, does it give them another tool in their toolbox that would change how they respond differently to dynamic pricing? So, the research that is being done in that area, that PIER is supporting, I think needs to continue to be done so that utilities and customers get more familiar with this technology that, you know, there’s lots of bulk storage technology that’s been deployed around the country, but when we start talking about distributed storage, that’s still kind of a new thing and I think both utilities and customers need to understand that, and one of the best ways to do that is to be able to see it, touch it, kick the tires, etc.

CHAIRMAN WEISENMILLER: Okay, and I actually – one question for LADWP, I did some work with the City Attorney down there in the ‘90s involving some litigation between you and Edison, and one of the outcomes of that litigation was a settlement where I think Edison contracted to use some Castaic, I don’t know if that’s still in place?

MR. BESHIR: No, that expired, oh, a few years back. That was just a temporary – it had a time limit, so it has gone a few years by now.

CHAIRMAN WEISENMILLER: Actually, the update, of course, we probably would be encouraging both of you to continue that sort of discussion if there is any unused capacity at Castaic that Edison might find some use for, or, for that matter, San Diego. And we certainly want to thank everyone for their participation in this panel, we certainly appreciate the opportunity to dig into these and to get this perspective. Mike, I’m sure we have more questions from the audience.

MR. GRAVELY: Well, actually, I think what we'll do, given the time and if the panel doesn't mind, most of the speakers are still here and so we'll go ahead and go into the public questions and I'll reserve my Next Steps until after the public comments. But what we do have in the first two presentations on the public session is we've talked a little bit about alternatives to classical storage, batteries, or flywheels, or other, and one we'll hear briefly, again, for the discussions in the afternoon, we'd prefer you hold your comments to less than five minutes, but preferably two to three minutes. But we're going to hear about auto demand response as one alternative, using existing systems for that, and then we'll also hear from Lon House about existing water infrastructure and how we can use that for similar, so if you know what you need, these are two alternatives, two possible very low cost alternatives to meet some of those needs. So we'll start off with Dave Watson from the Demand Research Center.

MR. WATSON: Thanks, Mike. And thank you all for inviting me here today. As Mike mentioned, I'm with the Lawrence Berkeley National Lab in the PIER funded Demand Response Research Center. We've been working on automated demand response for about eight years now and made significant progress probably best known for defining some of the standards that have been embraced by NIST and we now have over 100 megawatts under automated demand response in California using technology that we first started out as research, but has been turned over to the commercial sector. Now, all three IOUs, and CAISO are using technology developed by the DRRC.

What I want to talk about today is how demand response can be used as a resource for integration of renewables. And I'm going to start out first by differentiating what demand response historically has been, which has been very slow, it's been day ahead, typically, you know, telephone calls, even if it's automated, it oftentimes is day ahead announcements, and then also it typically lasts for many hours, you know, three or six hours, hot summer afternoons, traditionally. The more recent work that we've been doing has been both very fast, but with little or no advance notice, sometimes as little as four seconds, using the AGC signal from CAISO to do the automated generator signal, from CAISO to do near real time control of these resources, and in this test here, the red line shows – I'm pointing to what's called the "Fast Demand Response Aspect" – the red line is showing the signal that we committed to, and the blue line shows to what we actually achieved, so even though we only had to ramp up within 10 minutes, we actually ramped up in less than a minute, and this is a big box retail, and we think this is repeatable, and we did a scoping study and found a whole host of other types of commercial and industrial applications throughout the state, not just on hot summer afternoons, but also many of them in the other hours of the day.

So, why should we look at this? Lower cost. You know, we’ve seen a lot of costs here today, but after eight years of doing automated demand response, we’re seeing installed first costs between $75 and $300 per kilowatt installed. And we see those with mass adoption by control companies, those costs even dropping even further to become essentially zero incremental cost, because these codes are going into the Title 24, for example. So, when I talk about costs, though, even though that may sound very enticing, being, what, 10 or 20 percent of the cost of some of the other storage technologies that we’ve heard about, there still are challenges and demand response does not equal storage, it has different attributes. I think we all face some of the same questions about the economic incentives and those need to be looked at in more detail, but, in addition, demand response is different than storage in that it varies based on time and temperature to a lot greater degree. And we have little data about off peak demand response, although we're gathering more in this scoping study that we did, that I'll show you the results of in just a moment, shows that there is substantial resources, 24 hours a day, 365 days a year.

Another challenge is the monitoring and verification, and the telemetry required to show that something really has been shed. And then other issues that are common to distributed storage of geographic distribution and control, and so forth. These are some of the existing CAISO programs that we have participated in already, this is not just research, although these ones are pilot programs. We have participated in both Reg. up, Reg. down, and non-spin ancillary services, and we believe the technology is ready for spin, as well. I'll go through these kind of quick.

We looked at all different sorts of C&I loads for their potential and, you know, the ramp rates vary somewhat, but we believe that some can be as fast as a minute to 15 minutes or so and last anywhere from 20 minutes without even being noticed in many cases, to several hours. A couple that I'd like to point out, frozen warehouses appear to be a very good resource, you can sub-cool frozen warehouses and essentially use – when the prices go negative on the wholesale market, you can use that energy by sub-freezing. We see a lot of over opportunities in Ag pumping and data centers, also.

This shows – this is the results of a scoping study where we looked at commercial industrial loads all throughout the state, all different kinds, and looked at the peak hour of the whole year, and using a methodology where we took into account the existing control system infrastructure, which is a proxy for how easily and low-cost can we reach those loads, we can get about almost a gigawatt in the hottest hour of the year and in the middle of the morning in January, I think it was, we could get about a quarter gigawatt throughout the state. With modest investments in capital improvements, in control systems, and by “modest,” I mean increasing the penetration of energy management control systems in these facilities from, say, 30 percent in commercial buildings to 50 percent, and in Ag pumping from 10 percent to, say, 50 percent, we can double those numbers, so we can get, you know, the numbers that you see there, a half a gig to two gig, roughly. We see this working in conjunction and augmenting grid scale storage, they’re not apples and apples, they don’t come on line quite as quickly, but they appear to be a lot less expensive, so we imagine and request rules that would incentivize utilities and ratepayers to create programs that made it worthwhile to make this part of the loading order, where perhaps storage could come on line in a few milliseconds or microseconds, a fraction of a cycle, and perhaps demand response could be on line within a minute or five minutes later. And that could significantly shift the cost analysis of this equation. And, again, it’s a portfolio of products geared toward specific applications. And the application, as we all know, is to increase the use of renewable resources, which are variable.

This is just a little bit more detailed data, again, showing that these resources are variable. We are continuing our work on this area, but it appears very promising and I encourage demand response to be part of the discussion in the portfolio of products to integrate renewable resources in the state.

CHAIRMAN WEISENMILLER: Okay, thank you. I think the key question is, well, what are the policy measures we need for demand response, is it pricing signals? Is it capacity markets? What is it?

MR. WATKINS: Either of those would work. I like to think of it as – that structures are in place technology-wise for either of those to work, but if it’s financially viable, or mutually beneficial for ratepayers and utilities to create and participate in these programs, it will happen. And if doubling the rate during peak hours doesn't work, then maybe 10X will work. And I should note that, when prices go negative, the automated demand response works, as well, because, as I mentioned, there are cases like frozen warehouses, that could actually be paid to accept more energy, and then use it the next day, it wouldn't just be wasted.

CHAIRMAN WEISENMILLER: All right.

MR. GRAVELY: Having thought about this also, sir, one thing we mentioned is that, like in other cases, the current structure for demand response and the current rates are based on peak load, either peak load or load shifting, using this technology is something that needs to be integrated into the definition of what DR is and how it's used, and what it qualifies for. So there is, just like storage, there's a proof of the pudding, there's a demonstration phase, we've done some demonstrations as long as three and four years, we've done with Joe Etto [ph.] and the residential homes, but what we're running into is, going forward, in fact, that the world sees DR as a summertime peak load opportunity, and we need to change that for purposes of Grid integration, as a 24-hour seven day a week opportunity, realizing the quantity isn't quite as high, but the opportunity and the value is there. So, we do need to look at the way DR is defined in all of the documentation, and allow it to be defined in a manner that it's not just peak load or load shifting.

Any other questions? Thank you, sir. So, the next one, Lon House will give us a similar example of how we can use an existing infrastructure to address some of these issues also.

MR. HOUSE: Good afternoon. My first slide is what I'm not going to tell you about, you've already heard this afternoon about large pump storage facilities. What I'm going to talk about is very small pump storage facilities and give you a little bit of a quick background on the way water systems operate.

All water agencies that supply treated water have some sort of storage in their system. And storage has been added to their system to integrate with the water system, and you'll see an example a little later, but it is generally – it is not set up to deal with electricity, and to deal with the needs for storage here. The next one, and this is just an example, what you'll see is that a lot of the water systems, the storage is in one of two things, it's either on the beige thanks that you see on top of all the hills around here, or it is underground, and one of the things that the underground storage – and these two are to two huge underground storage facilities, but the ones that I’m actually talking about are what are called ASR, Aquifer Storage Recharge, in which water is actively injected into the ground. But what happens is, throughout the day, water is being pushed up into storage, or injected into ground storage, and then it’s used when it’s necessary.

So what I wanted to do is I wanted to just go through this real quick with you. This is one instance, this is the El Dorado Hills Fresh Water Treatment Facility, and the blue line is the pumping out of the Folsom Lake, and it’s running about a megawatt, and the red line is the fresh water treatment facility, and this is the demand response event, so you see what’s happening here, is this water during these other periods, the water is being used, it’s being either sent to the system or it’s being used for storage. When the demand response event hit, the water treatment plant shut down, 1.5 megawatts, and the pumping from the fresh water from Lake Folsom pumped down, so in this one instance here, in this one small system, you’re getting almost 2.5 megawatts of demand response. What you don’t see here is the generation, that’s because there isn’t any, because in this period right here, the water is still being sent out to the system, but it’s being sent out from storage. And one of the things that we talked about in the earlier part of this century was putting in generators for this time because, right now, the head from this, that’s coming out of storage, is just broken by pressure reduction valves. And we didn’t do that because there wasn’t any place to put the electricity, but this is just an example, you can see it works for demand response, this whole period, this six-hour period right here, that pressure is being broken by pressure reduction valves. It could be very easily run through a reversible pump turbine. Okay, what the water agencies right now drop between 400-600 megawatts every summer afternoon, so they’re used to doing that. And these are just some estimates that I came up with today of – there is the potential of about another thousand megawatts, I estimate, of either new facilities that are either re-operation of existing facilities, or the addition of some additional new facilities. One of the advantages is this is not a technology that we don’t know anything about, right? We know about how the big pump storage facilities work, we know how to operate the water systems, it’s much less expensive than other systems because you’ve got half of the system in there. You either have the ASR field under the ground, or you've got the storage facility sitting there, so the only thing that you have to do is you have to put a reservoir at the other end of it, and you need some sort of either take out the pressure reduction valves and put in generators, or you use reversible pump turbines. One of the really nice things about these is these are located right in the load centers, right? You can drive around anyplace that's got elevation, and you can see these tanks sitting up there right in the load centers. This would be really valuable to have, particularly if you get a big penetration of, say, residential photovoltaics, because you've got something that can respond, right, very very close. The disadvantage is they're a much smaller size. They're under 10 megawatts, they're generally two to five megawatts potential. They will require some additional analysis and investigation to figure out what needs to be done and how to integrate it with the rest of the water system, and quite frankly, there's no research being done on this. The Energy Commission, PIER, is not doing any research on this, and the water systems aren't looking at it because – right -- because what they're doing is they're interested in supplying water and this energy, they just basically say, "All right, fine, somebody else can figure out how to do this, but you have to prove to us that we can do this, it makes cost-effective sense for us to do this, and it doesn't mess up our system."

So this is just a summary of some additional information, but the one thing that I would encourage you to do is, while you're out there looking at all these other technologies, take a look at these. You've got half of the system already in place, it's not a technology that's foreign or exotic, or something that is foreign, we just need some demonstration projects and we need some additional analysis to be able to convince the water systems that it's in their best interest or in the state's best interest to do some modifications to their system, that are responsive to energy, not just to water concerns. And that's my presentation.

CHAIRMAN WEISENMILLER: Okay. So, one other question for you on the water agencies. I know San Diego Water Authority, obviously, has large pumps that they've got in a demand response program. In terms of generally on the water agencies, in terms of their pumping loads, how is that handled in the demand response arena? Is that another opportunity? Or is that already captured?

MR. HOUSE: Well, the total demand for the water agency demand is about 3,000 megawatts in the state, and that’s actually a study I did for you guys. And like I said, they are right now dropping between 400 and 600 megawatts every summer afternoon, that’s in response to two things, one is the bi-modal water supply that we need, the other is time of use pricing. But again, what they’re doing is they’re just operating their system to supply water and it’s been a – there’s about 150 megawatts of water agency load that’s currently in demand response programs, but it is something that is a tough sale – it’s not really a tough sale, but it’s something that they have to get used to because, if they start shutting things off in their system when they’re not used to doing it, they have to really make sure that everything else operates and their customers still get the water. And in San Diego County Water Authority, they’ve got – it’s either a 400 or – either 40 or 60 megawatt pump storage facility, but what I’m actually talking about here are the much much smaller ones, basically just the big tanks that you – you know, 8 to 10 million gallon tanks that you could fairly easily, without much new technology, convert to being able to either accept, or not accept, or produce electricity on a given day and upon call.

CHAIRMAN WEISENMILLER: Okay, thanks.

MR. HOUSE: Thank you.

MR. GRAVELY: So, Avtar Bining has been collecting the blue cards and I want to have him go ahead and call people up and then, afterwards, we'll take anybody from the audience that wants to speak, and anybody online who has questions that we haven't answered. So we'll start first with the people who have submitted blue cards.

MR. BINING: Yes, with the Chair's permission, we will allow these people to speak briefly for a couple of minutes to make their comments.

CHAIRMAN WEISENMILLER: That would be great.

MR. BINING: The first request is from Alfonso Baez from South Coast Air Quality Management District.

MR. BAEZ: Thank you, Avtar. Good afternoon. As Avtar mentioned, my name is Alfonso Baez, I'm a Program Supervisor in the Technology Advancement Office at the South Coast Air Quality Management District, and I would like to thank the Commission and staff for this very informative presentation and workshop on the various aspects of energy storage for renewable integration.

The South Coast Air Quality Management District has supported and continues to support clean renewable generation and storage; in fact, next week, Friday, May

6th, we're going to our Governing Board to release a request for proposal for the deployment of several megawatts of renewable – of in-basin [ph.] and renewable electric generation with storage to support electric transportation technologies. Through this RFP, the District will be making about $30 million available for deployment of these technologies. The funding comes from expected mitigation fees from the permitting of natural gas power plants in our district. Our hope and our goal for this RFP is to leverage the funding through this RFP, with other potential sources of funding, for example, CEC, DOE, SJP, CSI, and other funding to really move forward storage technology and renewable technologies. As I mentioned to Avtar, I've been wanting to come out here and mention this, we will work together, our agency, with the Commission, to move this very important storage technology forward in the future. Thank you.

CHAIRMAN WEISENMILLER: Thanks for your participation and for coming. I heard from a friend last night about the program and she was certainly excited about trying to participate in that. So I think you're getting a lot of interest in Southern California in this and, you know, certainly if there are ways we can work together on it, that would be great.

MR. BAEZ: Definitely, thank you.

MR. BINING: Thank you, Alfonso. The second speaker is Mr. Ed Stockton.

MR. STOCKTON: Good afternoon, Commissioners. My name is Ed Stockton. I'm the President and CEO of Hydrogen Technologies, Inc. I'm here today to ask you that the Committee include hydrogen storage and thermal hydrogen processes as viable options within the revised 2011 Integrated Energy Policy Report. We haven't seen a lot of hydrogen up here, it's kind of like it disappeared, however, Europe seems to be going hog heaven over it, in fact, one of the largest hydrogen generating companies in the world owned by State Oil, one of the largest –- well, it is the largest hydrogen generating company in the world, they're one of the largest oil companies in the world -- are coming to America very soon to begin deploying their hydrogen technology. We are working in unison with them.

Hydrogen technology has developed the hydrogen steam boiler. What is unusual about this hydrogen steam boiler is it doesn't require an air permit, it runs off of hydrogen and oxygen, not atmospheric oxygen, but oxygen made from the electrolysis of the water, from renewable energy. We built a 50 kilowatt unit in Modesto, California, the United Association of Plumbers and Pipefitters, it was a grassroots joint venture. We have several hundred people that have volunteered. We have the United Association of Plumbers and Pipefitters and the International Brotherhood of Electric Workers, who put this 50 kilowatt unit – I'd like for them to speak right after, they came here today to talk a little bit about it. On May 12th and May 13th, the California State Pipes and Trades Council is having a competition for all their apprentice down there and you and your staff are invited.

Why is this hydrogen steam boiler – and it's not just the boiler, it's the system – why is it important and have value to California? First of all, the question was brought up, is it volume, or is it a technological breakthrough? I think one of the most important parts about it is the mindset, it's how we as a community in our whole – how we as the State of California change our mindset on how we do business. I truly believe that the technology is here in the room to do exactly what you're trying to do. Being a power plant operator, running power plants for West Coast Operations for Florida Power and Light, both coal, gas, wind, solar, geothermal, the thing that drives the value – that was another question – what is the value of that storage? Value is directly related on any electrical delivery is based off of certainty. You contract forward based off of certainty, the higher the certainty, the higher the dollar value you get. That’s where the banks come in, they evaluate it. Hydrogen steam boilers have been around for 200 years, this is well known technology. Electrolysis has been around since 1925, this is all bankable technology. Our system serves as a battery to store and discharge power in the form of steam and/or electricity when needed, using stored hydrogen. It creates certainty in excess renewable power for wind, solar, and water movement. It strategically can shift power and time so that it can be used when it’s most needed, without creating air pollution. It allows energy to be stored and re-used cleanly, efficiently, and economically, even when the wind is not blowing and the sun is not shining, or the water is not moving. We’ve been recognized by the San Joaquin Unified Air Pollution Control District, and which they’ve given us a support letter for our technology. We’re using existing conventional durable power plant technology. It can be built very small, or very large. There are a couple more points, and then I’ll be done.

We believe that hydrogen and systems on hydrogen are critical components in achieving California’s

Renewable Portfolio Standard. We believe that it can be used in conjunction with an electrolyzer anywhere on the Grid to act as a load shaving or filling device to balance the Grid. But we’ve talked about electric cars doing that, well, the Norhwy, which is the Hydrogen Highway throughout Norway, Finland, and whatnot, they’re focusing on hydrogen, they’re focusing on a lot of things like we are, but the hydrogen highways are a real piece of equipment for them that they’re making. What that allows is to where, instead of deciding how the car driver is going to plug in whenever they decide they’re going to plug in, and I can tell you right now, trying to get my family to plug in to anything at any particular time that I want, doesn’t happen, but the bottom line is, that’s a lot more difficult. As an example, if the temperature for tomorrow is being calculated by the U.S. Weather Service and that goes into the CAISO model, and on average across the State of California we’re off by one degree, on average, that’s about an 800 megawatt shift up and down; what that means is that, if you could take 800 one megawatt units, a little over every six miles from Sacramento to San Diego, you could put a one megawatt load shaving device and filling device, which you could make that as part of your hydrogen highway. So, now, you can have a tank measurement of actual gas, so you're not relying on when the car is coming in, you just shave and load apparently to each place where the tank is at. Now, what I'm telling you is not a new idea, and I encourage you that people everywhere that I go and having hundreds of volunteers work on this project – volunteers, I might add – is that there's a huge social and economic desire for more distributive form of energy and it's known as the Intergrid. Some of you may have seen the CNN video, it's about a minute and 20 seconds, by a renowned economist, his name is Jerry Rifkin, if you go to Http://FOET.org, and watch him, he will talk about the Intergrid. There are three Intergrids that have already started, one in Houston, one in Boulder, Colorado, and one in Southern California. And this is where the common denominator is hydrogen. Hydrogen can be shared from pier to pier, pier to community, and it – he believes in his statement to CNN, he believes that this is going to be the third industrial revolution. To learn more about our hydrogen boiler, you can go to www.hydrogenboiler.com, and with that, thank you very much for the opportunity to speak.

COMMISSIONER PETERMAN: Hello, thank you, and glad you were able to bring that technology up in the workshop today. Just one follow-up question. Can you give me a ballpark dollar per kilowatt hour on using the hydrogen boiler?

MR. STOCKTON: It’s – hydrogen, there are two factors to everything, just like anything, it is the cost of your electricity going in and the cost of water if you decide if you’re cooling or whatnot. Typically, it can be anywhere from about – if wind costs you 5.2 cents a kilowatt, then you would multiply that a factor of a little over three, to up to five, depending on the technologies that are out there. So, 5.2 could cost you $.15. So, from a strategic time shifting component, then what you’re able to do is you’re able to take wind power like on the Altamont where they don’t even run them at night, they feather them because there’s no value in it, and you could now turn that into daytime power. And we know how much peak power costs and how that all goes.

COMMISSIONER PETERMAN: So, sorry, was the assumption there that you’re using wind to generate the hydrogen?

MR. STOCKTON: Wind, solar, water, yeah. Wind was the example of it, and then there are capital costs and however you lay that out. Our focus right now is on wind, that’s where we see the market.

COMMISSIONER PETERMAN: Thank you.

MR. STOCKTON: You’re welcome. Thank you.

MR. BINING: Yeah, the next speaker is Mr. Billy Powell from Electrical Workers.

MR. POWELL: Good afternoon, Commissioners. My name is Billy Powell. I represent the Electrical Workers in the Central Valley for Local 684. Obviously, there are many opportunities in different ways to apply storage. My request is that hydrogen definitely should be considered in your policy as you really make your policy coming forward. So, thank you very much.

CHAIRMAN WEISENMILLER: Thank you for coming.

MR. BINING: The next one is Bill Taylor from [Inaudible].

MR. TAYLOR: I always make that mistake and let Ed talk first. Bill Taylor, I’m with the Plumbers and Pipefitters over in the Central Valley Area. It’s pretty obvious from what Ed said, a boiler that produces steam without any emissions and how important that is to the plumbing and pipefitting industry. That’s what we do for a living, we install boilers and put in pipe. We see a great need in California for this type of technology. We feel that it’s going to be put in a lot of plants, retrofits, and things of that nature. It’s going to be a simple process. It can be configured to look and have the same connections as a regular boiler, so basically you're taking one out and replacing it with one that has zero emissions. So, we felt so strongly about the technology that we actually installed one in our facility for training purposes, and for HTI to demonstrate. And like Ed said, we're going to have a demonstration on the 13^{th}, and everyone is invited, and if you can't make that day, we'd be more than welcome to set something else up to where you can come and see it from start to finish. So, again, I'll just say that we think that hydrogen should be part of this plan and should be installed into it. So, thank you for your time.

COMMISSIONER PETERMAN: Thank you. Before you leave, can you give more information about the demonstration to the workshop leaders? That would be useful.

MR. TAYLOR: Absolutely, yes.

COMMISSIONER PETERMAN: Thank you.

MR. BINING: The next speaker is Harold Gottschall about sodium sulfur batteries experience in the U.S.

MR. GOTTSCHALL: Thank you, Avtar. As he said, my name is Harold Gottschall and my company is Technology Insights. I'm here on behalf of NGK Insulators. We were the manufacturer of sodium sulfur batteries. A little bit of history. A sodium sulfur NaS battery was developed by a utility, that's Tokyo Electric Power, for utilities. It's a six-hour battery. The first six megawatt unit was commissioned in 1996. We've been supporting NGK for the past 10 years. And the principle request I have of the body here is to address the problems that has delayed the commercialization of NaS batteries in the U.S. There's some 300 megawatts deployed worldwide; in that 10 years, we've only deployed 20 in the U.S., only 13 are operating, six of those are still in a warehouse in California for the last two years. The underlying barrier has been the legacy market structure and regulations that you've heard from other sources, that as you proceed into AB 2514, this is an issue that must be dealt with for any technology like a NaS battery, that is, a technology that will perform multiple functions and you've heard many of the speakers describe what those multiple functions are. Thank you for your time. I will put my suggestions in comments.

CHAIRMAN WEISENMILLER: Thank you for coming.

MR. BINING: Next, we have Amber Riesenhuber from Independent Energy Producers Association.

MS. RIESENHUBER: Good afternoon, Commissioners. My name is Amber Riesenhuber for the Independent Energy

Producers Association. First, I'd like to thank you for a very interesting and informative workshop today. As mentioned throughout the workshop, solar -- storage is one mechanism that can provide the ancillary services, Grid reliability, and load following requirements that will be needed to integrate the renewable resources. But while storage is one mechanism to provide these services and products, we think there are other technologies out there that can equally provide the products, as well. Our view is that we should allow these other technologies, as well as storage, to compete in the procurement process, on a competitive level playing field so that we can have the best solution at the lowest cost. We like solar – I keep saying "solar" – we like storage and we think that it's a viable option that we can employ as we move forward in the emerging and existing technologies, but we'd like to see it implemented and integrated in a low cost fashion, and through a competitive procurement mechanism. So, thank you for the opportunity to comment today.

CHAIRMAN WEISENMILLER: Thank you for coming today and thanks for your comments.

MS. RIESENHUBER: Thank you.

COMMISSIONER PETERMAN: Just curious, what are the alternative products to storage that you would like to see in the same competitive marketplace?

MS. RIESENHUBER: Well, we represent about 26,000 megawatts of all the different technologies that we think can also provide these ancillary services, and we'd like to see them compete, as well, with these solar technologies in the competitive procurement process.

COMMISSIONER PETERMAN: So gas plants?

MS. RIESENHUBER: Yes.

COMMISSIONER PETERMAN: Okay.

MS. RIESENHUBER: Thank you.

MR. BINING: One more, last one is Craig Horne from [inaudible].

MR. HORNE: Thank you, Commissioners. My name is Craig Horne and I'm CEO and Co-Founder of EnerVault Corporation. We're a venture backed company down in Sunnyvale and we're one of the ARRA storage demonstration award winners that were mentioned earlier with Imre Gyuk's presentation, putting a system down in Turlock, California at an almond farm, and one thing I just wanted to point out with that application is that there's a significant number of off-Grid diesel pumps used for groundwater and that would translate to between 600 and 900 megawatts of added load on the Grid if those were converted over to electric. If you look at the price of diesel today, $4.00 to $5.00 a gallon, it's getting pretty expensive to run the diesel pumps. The main reason I'm here is you asked a question earlier about is it going to take volume or breakthroughs to move things forward, and I want to echo the comments earlier about it needing to be volume. Being a venture backed company, we talk to a lot of different venture investors and the biggest thing that they're looking for is clear signals, and I think when you look at the technologies like ours and others, and you heard about today, they can be very cost-effective if the different value streams that they provide can be monetized from a single system, especially ones that are located down in the load center next to users. The other thing, on the notion of value, too, I wanted to put forth, is that we talked a lot about the present value and how it would impact the Grid today with avoiding T&D upgrade deferrals, or provide ancillary services, but the other way I think you should think about storage in the big picture is that is a buffer against future price shocks. If you look back in 2008, where natural gas went up to $12.00 or $14.00 a million Btu, even today, over in Asia now, it's up to about $11.00 a million Btu because it's pegged to the price of oil. Down the road, if we start getting back into a booming economy, a global basis, you might see these prices go up again, and with renewables having to be backed by things like natural gas, consumers will be subjected to large price spikes, so with storage and renewables, it might be higher cost at the beginning, but you have insurance against price spikes down the road, and so somehow if that could be figured in the value equation, I think that would be an important aspect. Thank you.

CHAIRMAN WEISENMILLER: Thanks for your comments.

MR. BINING: Yeah, we have a few questions on the WebEx here.

MS. KOROSEC: Mr. Shims, we're opening your line now. Go ahead and ask your question. R.J. Shims, you had a question about New York ISO. Are you on the line?

MR. SHIMS: Hello?

MS. KOROSEC: Yes.

MR. SHIMS: Hi, sorry about that. Yeah, my question just generally was, I know that, in New York ISO, they had introduced a year or year and a half ago a actual storage tariff and they had some at least demonstration projects, but utility scale projects that were going in, one of them may even be operational now, and I was just curious if anybody had any information or insights that could be shared from New York ISO, which it sounds like they're a couple years ahead of where

California is, in terms of doing something concrete with respect to promoting storage and its integration into the Grid.

MR. GRAVELY: Mike Gravely. I think we have our ISO representatives that are no longer here, so my personal experience in checking into these is we have companies from the East Coast coming out, looking for similar tariffs from on the West Coast, and I just – our structure is not the same as the East Coast, and our tariff structure is slightly different, and how they implement the FERC rules are different, and so I think we heard from our last representative that they are moving forward with storage tariffs and those types of things, but they haven't had as much of an aggressive direct interface as some of the East Coast ISO's have, so I don't know specifically what's happening out there, but I can tell you that our ISO is implementing the same rules, but not at the same pace.

CHAIRMAN WEISENMILLER: Yeah, but again, there is a demo down at the AES facility in Southern California that has an ISO storage tariff, so there is at least a demo in California.

MR. GRAVELY: That's correct, I'm sorry, there's one in Long Beach, there's a two megawatt system with AES, that's correct.

MS. KOROSEC: All right, next we have a question from Richard McCann. Richard, your line should be open. Richard, are you there? All right, the next one was from Jim Hicks, can you open Jim’s line? Oh, he is no longer online. All right, we have the written question, so what we can do is give those to our staff and then they can respond either via email or via a posting on our website. All right, we’re going to open all the phone lines. If there is anybody who was not hooked into the WebEx who would like to ask a question on the phone. All right, no questions on the phone.

MR. GRAVELY: Any further questions from the audience here? Does anybody have any questions that didn’t get a chance to come forward? Sure.

MR. WINTER: Hello. Thank you for the day. My name is Rick Winter. I’m Founder and CTO of Primus Power. We were mentioned a little earlier in one of the very large and colorful slides, I really appreciate that. I wanted to echo a few comments from before and perhaps give a little color to the volume vs. breakthrough question. It’s a very important question that needs to be, I think, there is no doubt at all in my mind that it’s volume, it’s not breakthrough. There’s a tremendous pent up availability of breakthroughs of intelligence and brilliance that we have in this state, and we're not utilizing it. I've been involved with four different start-ups in terms of building up storage technologies. I've been working in Grid storage for 22 years, starting on the small Coconut Island in the Torres Straight between Australia and New Guinea and the difference between running the company I have now and the three other companies is pretty dramatic, it started with a 75,000 CEC PIER EISG Grant and that built with funding from venture capital and from the Commission, enabling an ARRA Grant, and the difference in being able to get stuff done and knowing where you're going, and having some sort of road map, and being able to go to a vendor and say, "We're about to build a 25 megawatt battery, are you interested," the difference in being able to reduce the risks when you're looking to market opportunity is just night and day dramatically different. And that's what we don't have today, we just went through a round of funding, we just raised another $11 million. We went through a lot of venture firms and, thank God it's fun to do this because I've got to say, it's a little nauseating sometimes, but one of the biggest risks – I'll just tell you about three risks – there's technical risk, financial risk, and market risk, over and over and over again, it was the market risk that was the biggest problem with being able to see whether it is worth doing energy storage. And I think this is the area that the Commission can address and I think this is an area that is incredibly important to being able to solve a lot of the technical issues we've been talking about today. Thank you.

CHAIRMAN WEISENMILLER: Thank you for coming. Thanks for your comments.

COMMISSIONER PETERMAN: I'm also glad to hear that you were able to leverage PIER funding with venture capital funding, as well.

MR. GRAVELY: Last call for questions. Sir, last comments?

CHAIRMAN WEISENMILLER: I, again, thank everyone for their contributions today. I think we've had a productive workshop, certainly we have more coming up, a preview of coming attractions as we look at distributed gen on May 9th. I certainly would appreciate people's interest and comments on that.

COMMISSIONER PETERMAN: Yes, I'll just echo the Chairman's sentiments, great to see everyone here. This was a very fruitful discussion, I learned a lot, and am looking forward to engaging with all of you going forward on how we deal with this issue. Thanks.

MR. GRAVELY: Thank you. Commissioners, so I will close, I also want to thank Avtar for doing most of the work of setting up the conference, getting all the people here, the IEPR staff for arranging everything for us, so it's been – fortunately, we've had two good workshops, please provide us any written comments that you have, we can use your written comments as we work together and develop recommendations. As we develop recommendations, we will share those with the public, they will be part of the IEPR in the fall, and you will have a chance to review and comment on those. If you have questions, you can contact us any time, but we will take all the information we've gotten from the last two workshops, and the other workshops, and do our best to come out with recommendations for the future, and we would encourage your feedback from when we are able to put the recommendations together, and if you have specific recommendations, by all means, please send them to the docket by May 11th. May 11th is the deadline for comments – okay, May 16th, anyway, so please if you have information that you'd like to augment, that we didn't cover today, we'll also take that. And if there are technologies out there that we didn't get to cover, feel free to share those with us, we will be doing a technology assessment as part of the IEPR, so we would encourage your information if it wasn't presented either in November or today. Thank you all very much for coming and we appreciate all the time and your interest. Thank you.

[Adjourned at 4:31 P.M.]