

BEFORE THE
CALIFORNIA ENERGY COMMISSION

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) Docket No. 11-IEP-1N
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)
 Preparation of the 2011 Integrated)
 Energy Policy Report)

**Staff Workshop on Technologies to Support Renewable
Integration (Energy Storage and Automated Demand Response)**

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

TUESDAY, NOVEMBER 16, 2010
9:00 A.M.

Reported by:
Kent Odell

STAFF (* Via WebEx)

Mike Gravely, R&D Division (PIER)
Laurie ten Hope, Deputy Director, R&D Division (CEC)

ALSO PRESENT

Udi Helman, California ISO
Dave Hawkins, KEMA, Inc.
John Minnicucci, Southern California Edison
Doug Divine. Eagle Crest Energy
Frank Ramirez, ICE Energy
Janice Lin, California Energy Storage Alliance
Charlie Vartanian, A123 Systems
Robert Schainker, Electric Power Research Institute
Jeff Dagle, Pacific Northwest National Laboratory
Jim Parks, Sacramento Municipal Utility District
Mary Ann Peitte, Lawrence Berkeley National Laboratory
Albert Chui, PG&E
Jeremy Laundergan, Southern California Edison
Chris Villareal, CPUC
Don Erpenbeck, MWH
Rick Miller, HDRDTA
Eric Cutter, E3
Dave Watson, Lawrence Berkeley National Laboratory
Joseph Jamali*, Consultant
Walt Johnson, KEMA, Inc.
Antonio Alvarez, PG&E
*Carl Lenox
John Goodin, California ISO
Merwin Brown, CIEE
Ed Cazalet, Megawatt Storage

INDEX

	Page
Introduction and Opening Comments	
Laurie ten Hope/Mike Gravely, (CEC)	6
Workshop Overview - Energy Storage and Automated Demand Response (Auto-DR)	
Mike Gravely, (CEC)	10
Managing the California Grid and Integrating 33% Renewables	
Udi Helman, California Independent System Operator	23
Energy Storage, PUC Perspective	
Chris Villareal, CPUC	41
Results of PIER Research: Research Evaluation of Wind Generation, Solar Generation, and Storage Impact on the California Grid	
Dave Hawkins, KEMA, Inc.	46
SCE's Approach to Energy Storage	
John Minnicucci, Southern California Edison	65
The Use of Large Scale Pumped Hydro Energy Storage for Renewable Integration and Renewable Load Shifting	
Doug Divine, Eagle Crest Energy	77
Integrating Large Scale Distributed Energy Resources to Provide the Grid Megawatts of Energy	
Frank Ramirez, CEO (ICE Energy)	90
Importance of Energy Storage to California's Renewable Future	
Janice Lin, California Energy Storage Alliance	100

INDEX

	Page
Applying Large Scale Li-Ion Energy Storage Technology to Supporting Renewable Integration and Grid Services	
Charlie Vartanian, A123 Systems	112
Applying Large Scale Energy Storage to Support Grid Operations (Sodium Sulfur Battery Technology and Compressed Air Energy Storage)	
Robert Schainker, EPRI	123
How to integrate Energy Storage and Demand Response into the Wide Area Network Control of the Electric Grid	
Jeff Dagle, PNNL	135
Integration of Energy Storage and Automated DR onto the SMUD Grid Network	
Jim Parks, SMUD	146
Auto-DR and Renewable Integration	
Mary Ann Peitte, LBNL	155
Auto-DR for Ancillary Services and Integration of Intermittent Renewable Resources: PG&E Pilots	
Albert Chui, PG&E	170
Integrating Demand Response, Intermittent Renewables and Wholesale Electric Markets	
Jeremy Laundergan, SCE	180
Public Comments and Questions	189

INDEX

	Page
Next Steps and Plans for Spring 2011 IEPR Workshop on Energy Storage and Automated DR Policy Recommendations	
Mike Gravely, California Energy Commission	199
Closing Remarks (IEPR Committee and CEC Staff)	209
Adjournment	209
Certificate of Reporter	210

P R O C E E D I N G S

1
2 NOVEMBER 16, 2010

9:04 A.M.

3 MR. GRAVELY: Good morning, everyone. Mike Gravelly
4 from the R&D Division, Public Interest Energy Research
5 Program. Actually, Laurie, don't sit down, I want to
6 introduce you first. So, I would like to start off this
7 workshop by welcoming everybody here to the Commission.
8 This is an Integrated Energy Policy Staff Workshop. I will
9 talk a little bit more about the logistics of that. I would
10 like to introduce our Deputy Director, Laurie ten Hope, to
11 make a few opening comments and just put today's workshop in
12 perspective. Laurie.

13 MS. TEN HOPE: Good morning. And thank you all for
14 coming this morning. As Mike said, I am just going to
15 provide some opening remarks and context for the workshop
16 that we are going to have today. As Mike said, I'm Laurie
17 ten Hope, I am the new Deputy Director for the R&D Division
18 here at the Energy Commission. This is an important
19 workshop for us and very timely. We're here to talk about
20 Energy Storage and Automated Demand Response and the role it
21 can play in integrating renewables into the distribution and
22 transmission grid. As I'm sure all of you know,
23 California's policy is solidly committed to renewables.
24 We've had an RPS goal for several years and recently the 33
25 percent RPS has been incorporated into regulations at the

1 California Air Resources Board. The California Energy
2 Commission this year has sited eight large solar thermal
3 power plants for 35 megawatts of renewable central station
4 renewables, which is, if all built, somewhere around 10-15
5 percent of that goal. Our Governor-Elect Jerry Brown has,
6 in his clean energy plan, called for an additional 20,000
7 megawatts of renewable, 12,000 megawatts of which are on the
8 distribution system, so we have been thinking really about
9 the integration of storage at the end use and at the large
10 utility scale, but his plan, if it goes forward as
11 articulated at this point, really calls for a community
12 scale look, as well, which is a fair amount of renewable
13 generation on the distribution system, which creates new
14 challenges and opportunities for those of us in the research
15 area.

16 So, this workshop really is going to lay out some of
17 the challenges and the research opportunities for storage,
18 demand response, and other tools to manage the cost of
19 integrating renewables, while maintaining the reliability of
20 the grid system. This workshop is an outgrowth of the 2009
21 Integrated Energy Policy Report; the Policy Report sort of
22 laid out what some of the needs and opportunities were for
23 storage to perhaps address integration, first identifying
24 some of the needs, and I'm just going to read you a couple
25 of quotes from the 2009 IEPR. The first, "Significant

1 energy storage will be required to integrate future levels
2 of renewables, thus allowing better matching of renewable
3 generation and electricity needs. These technologies can
4 also reduce the number of nature gas-fired power plants that
5 would otherwise be needed to provide the characteristics of
6 the system needs to operate reliably." That statement right
7 there underlines the Skinner Bill, AB 2514, that perhaps
8 storage could mitigate the use of natural gas as a load
9 leveling strategy. "However, many storage technologies are
10 still in the research and development stage, are relatively
11 expensive, and need further refinement and demonstration."
12 And, you know, that is part of what we want to explore
13 today. What is the potential? What are the research
14 opportunities to lower the cost and really take this from
15 what we sometimes call the "Band of Miracles" if we are
16 going to get to our GHG goals and our renewable integration
17 goals. We have a lot of tools in our toolbox, but some of
18 the tools are still quite expensive, or really need some
19 technology breakthroughs to realize the potential that we
20 hope for.

21 A couple other points of context. As I mentioned,
22 AB 2514, the Skinner Bill, raises the bar on energy storage,
23 it requires the CPUC to look at regulatory strategies to
24 incorporate storage, and we hope that this workshop and
25 other work in the PIER Program will assist the Public

1 Utilities Commission in its responsibilities under 2514.

2 Today's workshop will address the current state of
3 energy storage technology and discuss the many emerging
4 technology demonstrations that are being funded through
5 DOE's ARRA Smart Grid funding. Under Mike Gravely's
6 leadership, the Energy Commission really went after Stimulus
7 funds in a big way and partnered with many of you and other
8 stakeholders in California to try to bring Stimulus funds,
9 both in the Smart Grid area and the storage area to
10 California. One unique aspect of this workshop is the
11 inclusion of automated demand response as a possible
12 resource to support renewable integration. So, we want to
13 look at the opportunities that DR can play, and maybe couple
14 with storage, maybe the whole is greater than the sum of the
15 parts in terms of the niches that each of these strategies
16 can play.

17 Today's workshop will help us define the efforts
18 needed over the next six months as the Commission staff
19 works with the ISO, utilities, industry, and researchers and
20 other key stakeholders, to determine what actions are
21 possible to accelerate the ability of energy storage and
22 demand response technologies to help California meet the
23 integration challenges that the Renewable Portfolio Standard
24 provides. I want to welcome all the presenters that are
25 here, all the other stakeholders that are here in the room,

1 and those of you on the phone participating by WebEx. And I
2 am now going to introduce Mike Gravely, who will take us
3 through the rest of the day. Mike is the Office Manager for
4 Energy Systems Integration and architect for much of the
5 Smart Grid and storage research here at the Commission. So,
6 Mike.

7 MR. GRAVELY: Thank you, Laurie. And I'll take just
8 a second here for a couple of administrative items. There
9 are about 50-60 people here in the room, so if we get a fire
10 alarm or anything, we would go out across the street to the
11 open park over there. The restrooms are right across the
12 corner. There is lunch planned and an afternoon break, but
13 not really a morning break, we'll see how that goes. We
14 have a pretty full agenda, so feel free to take a break if
15 you need during the session here. Also, I'd like to take
16 one second here and have our Administrative - would you un-
17 mute - I just want to be sure, will someone online simply
18 confirm that they can hear okay, and we're transmitting - I
19 want to be sure that the people on the WebEx are able to
20 hear and see the presentation. I will stand a little closer
21 to the mic here. And we will have people in the room go to
22 the mic; because this is also being recorded for purposes of
23 our notes and the for the IEPR presentation, those that come
24 in the room and want to speak, please go to the mic and give
25 your comment or question at that time, and we'll do our

1 best, to be sure. If you have a problem typing your
2 comments or whatever, we do have help here monitoring the
3 WebEx and they will be able to read your comments. There
4 probably will not be an open discussion session, and we'll
5 try and have one just before lunch for a few minutes, so if
6 you have questions that are coming up, I would encourage you
7 to type those in and they will be passed over to the
8 presenter and see if they can answer them. We probably
9 won't have a lot of open discussion in the morning, we have
10 over an hour in the afternoon for questions and answers to
11 cover things from there.

12 So what I would like to do now is just kind of
13 explain this workshop and what we plan for today, and what
14 we have planned for the next six months to a year in this
15 area. The overall purpose, this is part of our Integrated
16 Energy Policy Report preparation for 2011. The report will
17 actually be drafted in the fall and made out for public
18 comment, and it will be published before the end of the
19 year. We do these every year, this is what we call the on-
20 cycle - we have a two-year cycle for the report, 2009 was
21 the last one that we had a full report, in 2010, we had an
22 abbreviated report, so 2011 will be a full report, and 2011
23 is going to spend a considerable amount of time on
24 infrastructure, so obviously storage and renewable
25 integration is part of infrastructure, so this is core to

1 providing the data. The other thing important in this
2 workshop here is that we need to have the information that
3 we use docketed and part of the workshops, the public
4 workshops, so the presentations you see today may be longer
5 than the individual will actually be able to present, but
6 the important thing is to have the data into our record, the
7 information available, so if all the charts are not covered,
8 don't feel bad, the purpose of that is to ensure that we get
9 the information into the record and we're able to use that
10 information as we prepare inserts or sections for the
11 upcoming 2011 IEPR.

12 This is a two-phased workshop. Today's workshop is
13 going to focus on technology, and the ultimate question is
14 what is the state of technology now; one of the statements
15 in the 2009 IEPR was that the technology needed to evolve
16 and that there are some technologies that are mature, and
17 some technologies that are still developmental. So, we want
18 to try to put together kind of an assessment of where we are
19 as part of this work over the next six months. Also, most
20 of you know and you will hear today several presentations
21 under the American Recovery and Reinvestment Act, there are
22 a substantial number of storage projects, we are fortunate
23 that many of those are in California, and so that funding is
24 going to accelerate some of these technologies that may have
25 taken three to five years to mature, maturing one to two

1 years from that area. And also, we are looking today at
2 integrating automated demand response and I will talk a
3 little bit more about that as we go forward, as a grid
4 service, as opposed to demand response as a peak load
5 reduction service. So we are going to talk about it today
6 simply in the mode of, can Auto-DR provide a similar service
7 to storage with a similar envelope. And I'll show you those
8 as we go forward.

9 And then there are substantial barriers and
10 obstacles and challenges that we want to understand, so
11 today I'd like to simply identify those if we have the
12 opportunity. Certainly, I encourage everybody online and
13 all the participants here to follow-up this workshop with
14 more formal comments, more formal information, or more
15 detailed information. This is one area where I'm soliciting
16 all the vendors online and here to give us your marketing
17 and sales information so we know what your technology can
18 do, and what you say it can do, and it will help us
19 understand what is evolving in the marketplace. Again, for
20 this particular workshop, we're focusing primarily on grid-
21 connected large scale storage. I'll talk a little bit later
22 about what we're doing in other areas of storage, but for
23 this workshop and for this area, we want to look at
24 supporting the RPS. But that doesn't mean - large scale
25 does not mean aggregation of distributed resources because

1 we will have a discussion today of a very large distributed
2 resource, actually, that is providing multi megawatts of
3 service to the Grid.

4 And so we are planning a workshop in the April
5 timeframe, the date hasn't been picked yet, but we'll
6 probably post it after the first of the year, and then, in
7 that workshop, we will briefly summarize what we've learned
8 on the state of technology, but we'll focus most of that
9 workshop on what type of obstacles and barriers exist, what
10 types of policies and recommendations, can we address those,
11 and then what needs to happen so that storage can play a
12 major role as we think it should in the 2020 environment,
13 and what does it take to get there.

14 Also, I'll point out, for those that are familiar
15 with the Public Energy Research Program here under the R&D
16 Division, we have a long history in storage, we have hosted
17 multiple awards, we manage contracts, field demonstrations,
18 we share those publicly. Many of our demonstrations that
19 we've had in the past have gone on to some higher level of
20 commercial success. We encourage partnering. We've done
21 projects where we integrate renewable storage and community
22 scale projects, too. So, we are looking at different
23 opportunities. And one of the things we've been doing,
24 there are several members here in the Commission, myself and
25 Promode Kulkarni are two of them, they are kind of the

1 missionaries for storage. We have been preaching that
2 storage is something we need for a long time. I have
3 discussed many years ago that, for California to reach their
4 2020 goals, we need thousands of megawatts of storage on the
5 Grid that we don't have today. And fortunately, you will
6 hear a report from KEMA later today where we actually were
7 able to quantify that, and they also agreed, and ISO agrees,
8 that we need thousands of megawatts. How many we need and
9 what scale we need is still to be determined, short, medium
10 or long term storage. But I think people realize, if we're
11 going to do a third of our generation with renewables, that
12 we need substantially more storage, and then one of our
13 challenges is to figure out how to meet that need the most
14 effectively, and particularly the most cost-effectively.

15 The other area we'll talk about today, we'll spend
16 probably two-thirds of the session on storage, and a third
17 of the session on Auto Demand Response, and we have a long
18 history in Auto Demand Response in the PIER Program, we
19 actually formed the Demand Response Research Center about
20 eight years ago. We have been supporting demand response
21 research and the automation of demand response, in fact,
22 that automation has matured to an open ADR protocol as part
23 of the Smart Grid standards that are being negotiated right
24 now and because of that maturity, we think that technology
25 is ripe for this new opportunity, which really hasn't been

1 considered for a long time.

2 Here is just a collage of storage projects, we'll
3 hear many different types today, we'll hear about compressed
4 air, we'll hear about pumped hydro, we'll hear about
5 batteries and other systems out there today from different
6 technologies. We're not able to present every technology,
7 there is an open session and what we do allow, if someone
8 wants to present their technology or a project, you have up
9 to five minutes, I need you to make an arrangement by e-
10 mailing our WebEx and let her know that you want to speak,
11 or bring a blue card up here and, at the time of public
12 comment, we'll allow you to give a presentation, and we can
13 also upload a Powerpoint if you choose to do that. We will
14 stay here and take comments, there is an hour and 20 minutes
15 or so proposed for comments, but we'll take comments as long
16 as people want to talk, so there is an opportunity for
17 people that are not on the agenda that want to present
18 something that they consider of substance. We will welcome
19 that. Those of you that just want to send that in for us to
20 evaluate, or if you want to set a meeting up with us later,
21 Avtar Bining, who has been setting this up, is our Energy
22 Storage Manager, so he will be the contact if you want to
23 set something up with the Commission, work with him and
24 he'll arrange for you to come in over the next six months
25 and talk to us.

1 This chart here is the best I've seen and this is a
2 DOE chart that just shows you graphically the difference in,
3 we'll say today, this is renewable wind, primarily, but you
4 can see, if you go to 35 percent, which is pretty close to
5 33 percent, you can see the disruptions that it has on
6 generation in the system that don't like to operate that
7 way, so we have to find technologies to make upper lift for
8 some of those systems to continue to operate that way while
9 we handle the disruptions that occur because of the
10 renewables. The other chart that people see a lot is this
11 one, this is for actually California, it just shows you
12 that, you know, the average looks really nice, but the day-
13 to-day and the hour-to-hour projection doesn't look real
14 nice. And so we understand the ability to get lots of
15 renewables and lots of wind, and as we put more and more on,
16 we'll have more and more of those. So, the challenge,
17 again, for us is how do we use different technologies, and
18 storage and DR are two of those that can help us do this.
19 We want to make it work, and we want to make it work as
20 effectively as it does today, and as reliably as it does
21 today.

22 Solar, it does work when the sun is up, but it has
23 its own challenge, in California the sun comes up and it
24 gets hot pretty fast, and you can see that what happens is
25 the solar ramps up very fast, so we have a very large ramp

1 in the morning and a very large downturn in the evening, and
2 so there's a lot of transfer there and you need energy
3 protection to help that work for a small window, and so we
4 would prefer to have technologies that are available and
5 inexpensive, than having to have generation sitting there
6 for, you know, an hour in the morning and an hour in the
7 evening.

8 These technologies here, just a collage of the
9 different technologies and we will discuss over two-thirds
10 of those today, but not all of those, but we are looking at
11 all the different types. As I said before, today we'll be
12 focusing on large utility scale storage, but in the PIER
13 Program and in some of the research we're doing, we're
14 focusing on all storage.

15 There is a project that I want to point out, this
16 project is being managed by Avtar, it has been approved by
17 our R&D Committee, it is going through the process now of
18 negotiating and finalizing the contract, it will go to our
19 business meeting, we hope, before Christmas, if not, in
20 early January. It is about a six-month effort, and we are
21 trying to put together a vision for energy storage for
22 California. And so we will actually be looking at that
23 information. In this case, we'll be looking at not just
24 Grid storage, but all storage in this area, so we will be
25 looking at where storage should be and what happens, and

1 we're hoping the results of this information will be
2 provided to the PUC and also to other individuals, and so we
3 will do this interactively with industry, but the ultimate
4 goal here is to understand as we reach our goals of the RPS
5 and other greenhouse gas reduction goals, and Grid
6 management goals of 2020, how can storage play a role, and
7 what storage is cost-effective, and in what application.

8 Just to talk briefly about demand response, this
9 shows here that we have focused a lot of our attention on
10 automation of demand response. The lower left shows you
11 that we have a lot of success. You'll hear more this
12 afternoon from Mary Ann Peitte and other individuals that
13 will represent this. We have already done research for many
14 years on use and demand response as an ancillary service,
15 but primarily at a small scale, and we think, now, with the
16 integration of automation, if we're able to look at the
17 broader scale automation, then we can do this rather than
18 being hundreds of megawatts or tens of megawatts, it can be
19 thousands of megawatts, that's our ultimate goal because
20 cost-effectivity wise, we believe that the DR will be the
21 most cost-effective service, and then we have to go from
22 there to the storage. But DR cannot do it on its own, it
23 only has a certain piece it can play, but we want to use it
24 as much as possible.

25 And so, what happened here, this shows you the

1 classic Auto-DR, and that is that we looked at, you know,
2 the morning time and the peak time, and this just gives you
3 an idea of what a classical DR can provide and service.
4 What I've been trying to do now, and what I have challenged
5 the Demand Response Research Center for about six months ago
6 was to look at DR as a service and to define it the same way
7 we define storage; in other words, it takes so long to come
8 up and run, it'll run for so long and then it drops off.
9 So, give me that envelope and, based on that, I've asked
10 them to take this and say, okay, what will Auto-DR do? And
11 you help me, we think it can respond in 40 to 50 seconds,
12 and we believe in the future that might be 10-15 seconds we
13 can get a response time, we think we can get 20, 30, 40, 50
14 minutes pretty consistently, it could be hours. Our
15 research we've done to date shows that a customer, if we
16 have a 30-minute activity with an air-conditioning unit and
17 it's on and off in 30 minutes, the customer doesn't really
18 know what ever happened, and the Grid gets a response. So,
19 we could actually use Auto-DR and a Grid service much more
20 actively than we do right now, just on peak demand where we
21 want to do it 10 or 12 days a year, we could literally use
22 this every day and the customers would benefit for that, and
23 the Grid would benefit for it, and the cost-affectivity
24 would be substantially less than having to put in a
25 dedicated system.

1 Just as we mentioned before, we are fortunate,
2 California did receive a very large amount of ARRA projects.
3 In total, we got over almost \$500 million, this is just the
4 Smart Grid part of it; if you add it altogether, we have
5 about \$1.2 billion in Smart Grid related projects and those
6 include storage projects, and those include Auto-DR
7 projects. So, today's workshop, you know, we will advance
8 technology, the cost of the ARRA investment, there is no
9 question about it from there.

10 So, what I'd like to do now is just take one second
11 and go over the agenda. Let's see if I can get this to work
12 right. So, the agenda has changed just a little bit, but
13 the agenda is online, and for those of you online, you will
14 be able to see the presentations as we present it, but we
15 are posting those and they should be posted, if not by lunch
16 time today, but the end of the day. So, all the
17 presentations you see today will be posted and they are
18 publicly available. If anything happens and you can't get
19 them, feel free to e-mail myself or Avtar, and we'll be glad
20 to e-mail them to you. The problem with e-mail, of course,
21 some of these are very large and you can download them from
22 the Internet, but you can't always e-mail them.

23 So we're going to have just a few seconds here, the
24 PUC may be online and I think if Chris is online, he wanted
25 to make a few comments, and I'm going to let him do that,

1 and then we'll go into the discussions that we have here.
2 So we'll start off hearing from the ISO, and then we'll talk
3 about the Storage I've talked about that KEMA did for both
4 the ISO and the Energy Commission. And then we're going to
5 go through hearing from a different technologies and
6 different users throughout the day. We have a pretty broad
7 perspective, we're seeing everything from very large storage
8 to small distributive storage, and we tried to capture as
9 much as possible, all the major players and major
10 technologies that are out there. Again, I realize we can't
11 capture everything, but I also, again, will just keep
12 reiterating all day today, please provide me information
13 through the docket if you have information, you know,
14 everything is on the announcement where to send it, and then
15 we have that information available, so we're hoping to
16 provide a presentation to our Commissioners on the state of
17 technology as we go through this, and help them understand
18 that is possible as we go to the future. So, is Chris
19 Villareal on? Or, if Andy Campbell is on, they mentioned
20 they may want to talk for a few seconds. So, hello, is
21 Chris or Andy Campbell, either one on? At one time, they
22 were going to make a few comments. If not, later in the
23 day, I'll be glad to because they are setting up to execute
24 the AB 2514 and, of course, they're doing the Smart Grid
25 Deployment Plans also. Is anybody from the PUC on that

1 wants to speak? Okay, we'll check with them later and maybe
2 after lunch we can give them an opportunity to speak.

3 And with that, I'd like to turn it over to the ISO.
4 Let me get your presentation here for you. Okay, he will
5 load it real quick. So, I'll let you go ahead and introduce
6 yourself here and we'll go from there.

7 MR. HELMAN: Thank you for the invitation to the ISO
8 to kick this off. My name is Udi Helman, I am a principal
9 in the Market and Infrastructure Division and I'll be giving
10 an overview of some of the work that we're doing on
11 renewable integration and some of the implications for
12 storage and demand response. I wanted to say I also have
13 John Goodin, our lead expert on Demand Response with me, so
14 he'll be available for any specific questions on Demand
15 Response initiatives.

16 Okay, we have a lot of efforts and initiatives
17 addressing renewable integration and demand response and
18 storage, and we obviously don't have time to list all of
19 them, and I'm not going to try to, but this schematic gives
20 you a sense of the core functional areas in which these
21 efforts are advancing, and that includes our system
22 operations, the design of our wholesale markets, our grid
23 planning, and our support for the state's Resource adequacy
24 Program. The arrows that I have in this chart are just
25 indicating that, as new technologies come on board, and as

1 renewable integration studies advance, all these functions
2 become more and more integrated. I think, as all of you
3 know, the ISO last year implemented a new market design and
4 that's a market in which market price signals are much more
5 heavily a function of constraints on the system than they
6 were in the past, so we have a day ahead hourly market and a
7 real time five-minute dispatch market, all of which and both
8 of which prices are calculated on the basis of a full
9 network model that includes all unit operational constraints
10 in it, as well as transmission constraints. So, we have a
11 market now that is much more suited for the integration of
12 demand response and storage, as well as renewables. And we
13 envision, of course, that those market prices will be a
14 major piece of the control of both automated and
15 dispatchable resources in the future. At the same time, we
16 have evolving visions for some of the specific technologies
17 that are being discussed today, including demand response
18 and the Smart Grid. Again, I won't be talking about those
19 here, but look to our website for more information over the
20 next few weeks and months.

21 We also have some large storage in our generation
22 interconnection queue, again, I won't be talking about that,
23 but the revisions to our Grid planning process that we
24 submitted to FERC a few months ago specifically talked about
25 the integration of renewables and the integration of

1 resources to facilitate renewable integration, so we have as
2 part of our mandate to do a better job of understanding the
3 impact of both storage and demand response on Grid planning
4 going forward. So, there's a lot going on. I know it's
5 hard to keep track of everything that is going on at the ISO
6 and there are some central points on our website for our
7 different functional activities, but we can try to continue
8 to do a better job of ensuring that people can get there and
9 understand exactly what's going on with respect to storage
10 and demand response as we go forward.

11 Some of our objectives and principles, as we
12 continue, one, a really important thing from our point of
13 view, are to understand the multi-year operational and
14 market context to inform technology and infrastructure
15 investment decisions. So, that's a piece of the analysis
16 that has been hard to do in the past, given all the
17 potential scenarios for the future, but it seems to be
18 settling down this past year, a lot of work was done, and
19 this coming year, I think even more work will be done, that
20 will clarify the needs in the future. But, in the mean
21 time, I'll be talking about two studies that are ongoing
22 that we're doing that look out a few years and then sort of
23 two to three years, then out to 2020, and you know, we need
24 to keep clarifying the conditions on the system as they go
25 year by year, so we know the key junctures when new

1 technologies and new capabilities are going to be critical
2 to system operations. At the same time, we're also working
3 to reduce barriers to demand response and storage, mainly
4 the small scale storage, large scale can already operate
5 fairly easily in our markets, and we're thinking about any
6 new market products that are needed specifically to cover
7 new capabilities on the system. So, we have a number of
8 efforts in that area.

9 It is important to understand that one of our
10 principles at the ISO is that we're technology neutral,
11 we're not going to be in the business of picking particular
12 technologies to meet these needs in the future, we're
13 looking to policy and market price signals to guide those
14 decisions. I'm getting a little closer to the mic. So, we
15 try as best we can to remain technology neutral and to
16 provide the information on the combined operations of the
17 system using both conventional resources and new
18 technologies, so that decisions are as informed as they can
19 be as to where investments should be. So, we're technology
20 neutral, but we're also dedicated to ensuring that any new
21 technology can operate on our systems. And then, finally,
22 on this slide I should mention that one of the frustrating
23 things, I think, for entities trying to advance new
24 technologies is that we have to prioritize changes in our
25 ISO market and systems operations year by year, so while we

1 do our best to keep the ball rolling forward, we have a
2 backlog of changes that need to be made that are already
3 mandated by FERC, and so we're trying to get as many new
4 capabilities in the mix and lined up to be ready in time as
5 we can. We think that a lot of our initial backlog in terms
6 of our markets will be done in the next year or so, and we
7 are working hard to get the new capabilities needed to
8 integrate storage and demand response ready to go over the
9 next couple of years, so things will speed up even if
10 they've been taking some time to get to this point.

11 So, with that sort of very general background, I'm
12 now going to show some of our initial study results and talk
13 a little bit about those, and what we can learn from those,
14 and also to get into the state agency processes thinking
15 about how to improve the analyses that we do as we go
16 forward. So, the first of these studies was the study of
17 integration at 20 percent of RPS, and this study was
18 published just a couple months ago. It's the first attempt,
19 we think, to do both wind and solar resources at 20 percent
20 RPS in a detailed fashion, and the study, a draft technical
21 appendix, and stakeholder comments are available on our
22 website, and I encourage people to go and look at that.
23 Even though the objective of this workshop is 33 percent
24 RPS, there is a lot of information in that study that is
25 relevant to the system many years ahead, including some

1 inventories of our existing system capabilities that are
2 important to understand as we move forward. So I won't be
3 talking about too many of the results in this study, I will
4 be focusing a little bit more on our 33 percent simulations,
5 but it is still relevant to go back and look at it even as
6 we are thinking about 2020. And I will show some of the
7 types of results that I'm talking about.

8 Then, perhaps of more relevance to the discussion
9 here is our first run at doing 33 percent operational and
10 market simulations. All the information that we have so far
11 is available on the PUC website because we structured this
12 study in part to support the PUC's Long Term Procurement
13 Planning proceedings. So, we have been channeling those
14 results through the PUC workshops and will continue to do so
15 into the near future, although, as we continue to
16 articulate, our analysis, we are doing it as if with our own
17 objectives in mind, as well, we're not simply there to
18 provide information to the PUC, we have to do our own
19 preparations on our ends, and so how we go about these
20 studies is informed as much by our own objectives as it is
21 by their objectives. And we also emphasize fairly
22 consistently that, as was pointed out by Mike, there are a
23 lot of uncertainties about future technologies, future
24 conditions that have to be taken into account when we look
25 at results 10 years out. We are going to produce another

1 round of simulation results on November 30th and that will be
2 at another PUC workshop in this process, so that will add
3 another set of possible future needs and outcomes to the
4 discussion. And I think some of you will be pretty
5 interested by what those results are. But I can't show them
6 here, sorry.

7 I guess Mike already showed what the world looks
8 like in 2020. These are individual days that we're modeling
9 in our simulations, so this is a [quote] "high wind" March
10 16th day in 2020, so you see the wind - and these are
11 profiles built up from a one-minute basis, based on analyses
12 that we prepared, so I will not go into great detail into
13 the methodologies, but we are doing analysis on the one-
14 minute, five-minute, one-hour sort of timeframes in our
15 simulations, so you can see some of the variability that
16 builds out from a one-minute basis in this graph. What's
17 important from a storage point of view is, you know, what
18 role is storage going to play, and I think there will be
19 some counterintuitive results coming out of these studies.
20 I know that our 20 percent study already showed some
21 interesting results, there is a slide that I will talk to
22 about those. But we can see obviously that storage and
23 Demand Response have a role to play in variability, and that
24 was already discussed. But the value proposition will also
25 come out of what prices will be telling us, and I think what

1 is very interesting about 2020 and even about two to three
2 years out is the immense displacement of gas by renewables,
3 affecting energy prices, and we showed some of that in our
4 2020 percent report already, showing a big drop in, well,
5 not as big a drop in energy prices, but a big drop in energy
6 revenues for gas plants. And this purple line in this graph
7 is the net load, that is the load minus the wind plus solar,
8 and it is this pushing down across the entire day that you
9 have on days like this, that pushes the energy prices down
10 both in the off-peak and the on-peak. The expectation used
11 to be that you'd get a big gap opening up between off peak
12 and peak, but with the inclusion of all this solar in the
13 current forecasts, you get a suppression of energy prices
14 both in the off-peak and the peak, so the value of energy
15 arbitrage may be less dramatic than one hopes by 2020, and
16 that will also be a function, of course, of whether this
17 carbon pricing to push up the on-peak prices, as well. So
18 there are a lot of variables in understanding what the real
19 value proposition will be for storage and demand response.
20 The other interesting thing is that peakers in our models
21 are no longer really peaking resources, they're variability
22 resources because of this solar influx that knocks out, you
23 know, gas off the peak. So, just in our 20 percent study,
24 we showed a huge shifting in the revenues to using an hourly
25 model, and there are a lot of caveats here that have to be

1 explained, but the less efficient gas plants are obviously
2 pushed out of the peak. But then they retain some value in
3 providing support for variability within the hour that we
4 have to understand better. And then, another profile, as
5 you know, the variability will be dramatic and so this is a
6 low wind summer peak day, and here we see that the solar is
7 doing most of the work in displacing gas across the day.
8 And so the impact across seasons, across different days on
9 prices, will be extremely variable and there is a lot of
10 work to understand that.

11 Our general sort of results from these renewable
12 integration studies of interest to storage and demand
13 response is significant increases in the intra-hourly load-
14 following, and its generic terms is load-following, but it's
15 really load-following and variable renewable-following
16 requirements, and as the two graphs I showed just now, these
17 will vary by season and by hour, so there will be hours of
18 the day in which there will be a very high need for
19 resources that can follow variable renewables and there will
20 be hours of the day in which there isn't as great a need,
21 and that will vary by season. But there's no question in
22 the analyses that we're doing that we see significant
23 increases, and one of the things that is helpful about our
24 work is that we're helping to clarify and quantify some of
25 that. And similarly, we show significant increases in

1 regulation requirements, also varying by season and by hour.
2 As I discussed earlier, the energy market prices are
3 expected to decline as renewable energy displaces gas across
4 the day, and that is the combination of wind and solar,
5 however, real time prices will be expected to become a lot
6 more volatile as the intra-hourly market provides that load-
7 following function, and so there is a lot of potential there
8 for storage resources. And then, ancillary services
9 markets, obviously we'll be procuring more ancillary
10 services, but what the impact on prices will be, will be a
11 function of a number of factors, including what other
12 resources are on the Grid, including the gas plants that are
13 displaced out of energy, but a lot of which are still
14 committed and will be available to provide ancillary
15 services. So, these are really complex modeling issues and
16 we're making progress, but they do affect the sense of how
17 much storage and demand response would be needed.

18 So here are some of our attempts to quantify these
19 changes on the system, this first slide is load-following up
20 by hour in the summer season, using the PUC's 2009 33
21 percent reference case, that was a case built out on the
22 basis of existing contracts largely, and has about, I think,
23 10 megawatts of solar in it, with the remainder being wind.
24 And this shows you that - this is essentially telling you
25 that, within the hour, we'll need - the blue graphs, the

1 blue plots are a benchmark year, we try to have a benchmark
2 year in each of our analyses that we can measure the change
3 in the system. This benchmark happens to be 2005. And then
4 the red is the target year in 2020 and we can see that we
5 need about a thousand or more megawatts of basically upward
6 capability available within the hour, typically. So that's
7 what that is showing you. In some hours, more than a
8 thousand, closer to 1,500 megawatts more, on average, than
9 we have now. Let me just say that one of the other
10 improvements that we did in these studies over some of the
11 prior studies was we tried to give a sense of the range of
12 possible results that will happen over the year, beginning
13 from some baseline profile of renewables, so that, you know,
14 past studies have often shown you the maximum requirements
15 on the system, and one of the questions was, well, how often
16 does that happen? And we've really tried to go a long way
17 to explaining how often that would happen in these more
18 recent studies. So, both in these kinds of plots and in
19 frequency distribution plots that are both in the slides and
20 in the studies, you get a sense of, well, yes, here is an
21 example of where the simulation, if we look at essentially
22 Hour 7, shows you almost 5,000 megawatts of load-following
23 needed on the system, up from the simulated 3,500, but that
24 is only happening for an hour, so in the simulation of 87/60
25 hours. So, getting that sense across has been important and

1 we have an ongoing discussion about refining this modeling,
2 but I think everyone has appreciated that we're providing
3 this further type of information as we go forward. And
4 similarly, these are plots of that same scenario for
5 regulation in 2020 and, again, you have heard that we need
6 over 1,000 megawatts of regulation, you've heard that in the
7 past, but these simulations results help show you that,
8 well, that may only happen in a particular hour of the day
9 and, for the rest of the hours, we may not need more than
10 between 400 and 600 megawatts of regulation. And then,
11 there are further caveats, like what if the renewable
12 resources become more dispatchable? For example, as we go
13 to the next slide, in the instance of providing regulation
14 down, what if the renewables become more dispatchable in
15 certain hours to reduce overall system costs, they would
16 further cut off some of these requirements. So, there are a
17 lot of moving parts. Forecast errors - if we reduce
18 forecast errors further, we will reduce the estimates of
19 these requirements on the system. So, these are all
20 considerations as we go forward to help clarify and there is
21 a lot of discussion of this in our studies.

22 Another important piece of information that we have
23 started to put out, and again, this was in the 20 percent
24 report, is inventories of what capabilities we have on the
25 system now, and so we have a number of tables in the study

1 and we'll be providing those, more of them, in the future,
2 that inventory, our generator fleet, by operational
3 characteristic and by unit type, and that includes ramp
4 rates, how much capacity we have that can provide particular
5 ramp rates, start-up times, and regulation, certified
6 ranges, and ramp rates. And I'll show you one of those
7 tables in a second. And then we also classify them by unit
8 type, so OTC vs. non-OTC units, for example. And I'll also
9 show you, in the 2020 analysis, we're looking at different
10 future fleet mixes, so looking at potential future fleet
11 mixes and what capabilities we'd have on the system, and
12 those scenarios. And that's where, as I'll describe, we
13 haven't yet gotten to including large scale storage as part
14 of that future fleet mix. But it's useful to benchmark it
15 with conventional gas plants, and then we can move to
16 understanding storage on a large scale - better. So, this
17 is an example of - this next slide is the inventory of our
18 current fleet, and one of the things that we did in the 20
19 percent report was try to explain better to the market,
20 especially the storage market, the smaller storage, in
21 particular, you know, what potential is there for providing
22 regulation in the future. That's considering what is
23 already on the system. And I think what may have been
24 surprising to some people is that there is a lot of
25 regulation certified capacity on the system; at the bottom

1 right-hand point of this table, you see there is almost
2 20,000 megawatts of regulation certified capacity across the
3 different types of units that are already on the system.
4 And then, our simulations, both on the 20 percent study and
5 the 33 percent study, have tried to carry the additional
6 regulation requirement as part of the production simulation
7 in the future, to see if we can create a unit commitment
8 dispatch that provides the additional regulation needed, as
9 well. And so, what this is telling us is that - and there
10 are some other analysis in the study, as well - is that,
11 yes, we will need to buy more regulation, but there is a lot
12 of existing capability to provide that regulation and we can
13 generally commit the units to provide that capability with
14 our existing fleet. So, what that is telling you is that
15 the value of regulation will take time to show up, even as
16 we get additional renewables on the system over the next,
17 you know, on an increasing basis over the coming years.

18 This is just a piece of information that I think has
19 been important to get across, it's just objective
20 information. So, this table is one of these look-ahead's to
21 33 percent and what this is telling us is that - and what I
22 just said, you might consider to be an issue for the
23 valuation for storage over the next few years - but as we
24 look out 10 years, one of the things that we're starting to
25 catalogue and model is the impact of the additional

1 renewables as they qualify as resource adequacy resources
2 given the current rules. They displace conventional
3 resources from resource adequacy, credits -- essentially
4 capacity credits. So, if we build out a system that meets
5 the planning reserve margin, the remaining resources, what
6 this chart is showing you, and obviously it is hard to see,
7 but there is another graph coming up, the remaining
8 resources have less and less flexibility on them because
9 there are fewer and fewer gas plants that are eligible to be
10 resource adequacy resources, and energy market revenues are
11 declining. So, there is going to be a lot of cost pressures
12 on them and the remaining ones will be - have less and less
13 flexibility. And that is what this chart is showing you,
14 it's showing you that these are across the columns, the
15 first one is an all gas benchmark column, so that is as if
16 we included only additional gas between now and 2020, and
17 then there is incrementally higher and higher renewable
18 scenarios. So, the next column is 20 percent RPS in 2020,
19 and then a 27.5 RPS in 2020, and then a 33 percent RPS using
20 the portfolio that I discussed earlier, and then various
21 other scenarios like the high DG scenario, and the high out-
22 of-state scenario. And this green column, green row, is
23 percent reduction from the all gas case, so we see that, by
24 2020, there is 16 percent less regulating ranges, eligible
25 regulating ranges on the gas fleet than there is in the all

1 gas scenario; and similarly 20 percent less ability to
2 provide load-following. So, this chart, in comparison to
3 the last chart, I think, is a good news chart for storage
4 and Demand Response because this is saying that system
5 requirements - the flexible resources, the ones that are
6 able to follow dispatch, will become a narrower and narrower
7 band of the system. And that's where the opportunities lie
8 for newer technologies.

9 In this next graph, and I should just also mention
10 that these two graphs I've shown, these are not simulation
11 results, these are inputs into a simulation, so these are
12 just - this prior slide 14, this table, these are just the
13 power systems that we are modeling in the simulation, and
14 these measurements I've done about capabilities are just
15 looking at the ratings of the plants that we're modeling,
16 and fattening them up, essentially. So, this is going into
17 the simulation and the results coming out of the simulation
18 will be available at that PUC workshop that's coming up at
19 the end of the month.

20 And this graph is a version of - this shows on the
21 blue line that the sum of the regulation load-following
22 requirements goes up as we go from the all gas in 2020 case
23 to the 33 percent case, and the red line is showing you that
24 the capabilities, the sum of the capabilities on the system
25 is going down, so that's just another illustration of what I

1 was just describing.

2 So, where do we stand and what do we plan to do
3 next? The 33 percent simulations, as I said, additional
4 results, I should say, a bunch of results are already out
5 there; additional results will be available at the end of
6 the month, but then we're getting a batch of updated PUC
7 scenarios, and so we're going to have to re-run everything
8 again another time over the next few months. So, our focus
9 has been on methodology so far, we wanted to get the
10 modeling in a reasonable shape, in a way that people
11 generally agree that the results are meaningful, but then
12 we're going to do some updates over the next few months, so,
13 you know, obviously all of this will be updated
14 continuously, but we will do some - it's worth looking at
15 the results and understanding what they're telling us, and
16 then, you know, we will be continuing to analyze it.

17 One of the weaknesses of the analysis, so far, of
18 the 2020 case is that the production models, the ones that
19 are modeling the entire system, hour by hour, have not yet
20 drilled down on an intra-hourly basis. We have intra-hourly
21 requirements that are calculated through a statistical
22 model, and I showed some of those results earlier, but the
23 production model isn't fully capturing some of the
24 incremental and decremental ramps within the hour, and we
25 want to do some further work on that and that will provide,

1 I think, more insight into the capabilities of faster
2 ramping resources. So far, we have in the models, if you go
3 and look at them, we've held sort of capacity in reserve to
4 account for those upward and downward requirements within
5 the hour. So, there is more sophistication coming, and of a
6 type that will be useful, I think, for storage and Demand
7 Response. Of course, every time we have a meeting, we get
8 the police from the storage community to do more analysis of
9 storage in these simulations, and it is in our plan, it's
10 hard to model storage in some of these modeling frameworks,
11 but that is the next step on our agenda and that will be
12 announcements that will happen in this coming year. So, be
13 patient, but the results that you see so far are still
14 useful results, and even in thinking about storage needs and
15 storage capability. So, you know, we will do more as we go
16 forward this coming year.

17 And then, finally, I just want to say that, on the
18 market side, we are proceeding to speed up our abilities to
19 introduce limited energy storage into our markets, so there
20 is an initiative this year and the coming year to introduce
21 a method called regulation energy management for those types
22 of resources. So, a lot going on, and I'll be here in the
23 morning to answer questions, but I won't be here in the
24 afternoon.

25 MR. GRAVELY: Okay, thank you very much.

1 MR. HELMAN: Thank you.

2 MR. GRAVELY: Okay, the next presentation is by
3 David Hawkins here, but just before Dave, the PUC is online
4 here, so we're going to wait and maybe have questions at the
5 end since a lot of the ISO type of information is in the
6 report, we're going to hear from now. I would like to go
7 ahead and have you open up the line. Chris Villareal from
8 the PUC, who has been working with us and our partner on
9 this effort, and is managing the Smart Grid effort, the
10 rulemaking, and also actively involved as they are preparing
11 for the AB 2514 work. Chris, are you on?

12 MR. VILLAREAL: Good morning, can you hear me?

13 MR. GRAVELY: Could you speak up a little? We hear
14 you, but you're weak.

15 MR. VILLAREAL: All right, can you hear me? So,
16 good morning, everyone. Thank you, Mike, for letting me -

17 MR. GRAVELY: Hang on one second, Chris. We're
18 going to try and change your volume a little bit here. Try
19 it now, go ahead.

20 MR. VILLAREAL: Okay, hi, Mike. Can you hear me?

21 MR. GRAVELY: That's much better.

22 MR. VILLAREAL: Okay. Good morning. I want to
23 thank Mike and the CEC for letting the PUC have a couple of
24 minutes to give our view point on Storage. The PUC
25 obviously has a very strong interest in supporting storage

1 as we view it as a critical technology to help meet our 20
2 percent and our future 33 percent goal of intermittent and
3 renewable resources. Additionally, as we start shutting
4 down the once-through cooling facilities and increasing
5 loads through electric vehicles, storage is going to have an
6 even greater role, not only on the transmission side, but
7 also on the distribution side. So, the challenge for the
8 PUC is how do we adequately account for the various revenue
9 streams that are coming from one storage facility when that
10 storage facility can act as a generator and act as
11 transmission support, and can act as supporting
12 distribution.

13 Recently, Governor Schwarzenegger signed AB 2514,
14 which directs the PUC to open a proceeding by 2012, to
15 address policies, to incentivize storage on this cumulative
16 [ph.] level if we decide to set up storage on this current
17 [ph.] level if we decide to set up care [ph.] with storage
18 target. Again, the issue will be how do we adequately and
19 accurately measure the cost-effectiveness of any storage
20 project. The two clear issues are, which is the right
21 technology, and what is the most economic for customers, not
22 that we want to pick technologies, we'd rather just have it
23 be technology neutral, and let the utilities on the market
24 decide which technologies meet the goals and the needs of
25 California customers and the system as a whole. So, the

1 proceeding that we plan to open up soon will address how the
2 PUC should best create policies to allow storage to take a
3 greater role in utility infrastructure and operation. I'm
4 with the PUC's Policy and Planning Division, and earlier
5 this year, we issued a White Paper that laid out some
6 initial thoughts and options as to how to move forward. One
7 option, as indicated in AB 2514 is to create a procurements
8 target. There are a number of other options such as
9 creating other incentives through contracting that may be
10 more efficient in getting the right technologies into
11 utility hands. One of the concerns that we've heard
12 regarding the procurement targets is that all it does is
13 incentivize existing storage and not necessarily the cutting
14 edge technologies that we are all so interested in today. I
15 know that Udi said that following storage at the ISO is
16 quite challenging, and I would argue that it is even more
17 challenging at the PUC, as we have currently five different
18 proceedings that all, at one point or another, will address
19 integration of storage. We have an RPS, we have the
20 procurement, we have Demand Response, we have Distributed
21 Generation, and we have Smart Grid. In addition, as storage
22 becomes more robust and is taken into the utility rate
23 cases, we have these rate cases themselves, and we also will
24 have future issues with storage and resource adequacy, as we
25 decide whether or not to give storage - not only whether to

1 give them a capacity value, but what should that capacity
2 value be.

3 And finally, I just want to point out that the PUC
4 in our Smart Grid phase has so far approved two storage
5 projects that received Stimulus funding, the first one is in
6 PG&E's service territory, which is a compressed air storage
7 project, the funding we approved is only for Phase I of a
8 three-phase project, Phase I addresses the feasibility
9 study. This project is located in the Central Valley. I
10 can't quite remember where in the Central Valley, but if
11 there is a representative from PG&E there and it comes
12 around, he can address it. And the second project we've
13 approved is, I believe, a four megawatt or an eight megawatt
14 battery storage facility located at the Tehachapi site on
15 Edison's transmission site. Both of these projects have
16 been approved by the PUC and, to my knowledge, are still
17 awaiting funding from DOE.

18 So, all I have to say is that the PUC expects
19 storage to take a greater role and we expect to create
20 policies in the near future to allow utilities and to create
21 a market for storage where appropriate as we move forward in
22 this brave new world of increasing renewables and EVs and
23 more distributed side generation and storage. And we view
24 storage as just being one of the - to use a phrase I
25 actually don't like using - to be a "killer app" in this

1 brave new world of the electricity Grid going forward. And
2 that's all I have to say, thank you.

3 MR. GRAVELY: Thank you, Chris. Also, is the volume
4 any better? I noticed we had it down low here, we tried to
5 correct that for those online, so maybe -

6 MR. VILLAREAL: Um, what happens -

7 MR. GRAVELY: Okay, you're back on, Chris.

8 Unfortunately, he muted you. Go ahead.

9 MR. VILLAREAL: Oh, sorry. The problem that we had
10 on the phone is that we would lose every couple of words
11 from the speaker.

12 MR. GRAVELY: Is it any better now? Because the
13 volume was down lower on our reception. Is it any better
14 now than it was?

15 MR. VILLAREAL: I can hear you.

16 MR. GRAVELY: Okay, well, for those online, and
17 also, Chris, we are going to cover both of those projects
18 today, both I believe in the afternoon, one is before lunch
19 and one is after lunch, so we are covering both of those two
20 projects you discussed, the SCE project and the PG&E
21 projects, in addition to other projects. So, with that, I
22 would now like to go ahead and welcome Dave Hawkins. I
23 guess he's one of the other champions of storage for around
24 the country, and so PIER was fortunate enough to work with
25 the ISO and KEMA to fund a study a while back, and this is

1 the first time we have a chance to really try to quantify
2 what was going to be needed in support, and so I will let
3 Dave go through the details, and hope at the end there will
4 be five or 10 minutes and maybe we can bring Udi back up
5 here, and David, for questions for the ISO, and we'll start
6 with the audience here, and if we have time, we'll go
7 online, but at least there may be a chance for a couple
8 questions while we have ISO and prior ISO employees here.

9 MR. HAWKINS: Thank you very much, Mike. The work
10 that we did on energy storage was actually done the latter
11 half of last year and then the report was published this
12 June. It's always a moving target, you know, when you look
13 at something, what is the scope, and what date you have at
14 any particular point in time. The thing that is
15 interesting, of course, when we did this study, the big
16 driver for energy storage was going to be renewables, you
17 know, the big variability of what we're going to see by 2020
18 and so forth, in terms of the different types of renewables.
19 Of course, today if you look at it, you'll say, well, okay,
20 as we heard from the CPUC, the big driver is AB 2514, that
21 says we've got to come up with a plan for storage, how we
22 going to use it? And I think what you heard from Udi, too,
23 was that the market side has only a small piece of how to
24 value storage, there's still more pieces coming. So, if you
25 look at what EPRI has published, there's a list of about 20

1 different things, value change that storage can provide, and
2 only about four or five of those things are actually
3 monetized on the market, and so there are things that say,
4 okay, what happens if it's the end user, what happens if
5 it's out on the distribution system, where is it on the sub-
6 transmission system, as well as on the transmission itself.
7 So, as you look at the build out of Automated Demand
8 Response programs, ADR, and energy storage at different
9 levels, there's a lot of things yet to be studied, and so
10 this is one snapshot in time that we did last year to look
11 at this. This is the report that was published, which is
12 available on the website, and again, it's very interesting
13 to think about where we're going and what we're trying to
14 do. Our objective at that point last year was to really
15 kind of model in detail the inter-hour variability. Udi
16 talked about the fact that their production costing
17 simulation models really do a terrific job of looking at how
18 you displace gas-fired generation with renewables, the big
19 impact of wind, and solar, and so forth, on these systems.
20 But the problem is, when you get down to try and look at the
21 minute-to-minute, or second-to-second variability, that is
22 going to be the real challenge, and where is the role of
23 energy storage, and so forth, and how do you really model
24 those. So, this was our project objectives. Again, it was
25 very limited in scope in the sense that we were doing it in

1 a very short amount of time and we did not include the
2 Demand Response piece of it. But we were looking
3 specifically at storage and what would be the amount of
4 storage it would take, how it would in fact impact the
5 ancillary services regulation. And then, also, we were
6 looking at how does storage play off against heat
7 (*combustion*), I could put in a real fast gas turbine, you
8 know, should I use storage? Or should I use a gas turbine?
9 So there was an evaluation of a 100 megawatt combustion
10 turbine compared to using some amount of storage. And then,
11 finally, what are the policy issues that are affecting all
12 of this? So, again, the goal was to try to take all this
13 data that we had at the ISO of second-to-second, or four-
14 second type data, on a lot of the renewables, play that into
15 a model, and the model that we used was a system called
16 KERMIT, which is more like a Matlab-like model, and so it
17 has all the feedback, control loops, and everything else,
18 and then to actually put together this simulation model and
19 looking at how that would - the second-to-second, minute-to-
20 minute variability, and the role of energy storage as part
21 of that.

22 We also were not only modeling the way the EMS or
23 Energy Management System AGC system worked, we also
24 implemented the five-minute economic dispatch that the
25 market system does, because, as Udi mentioned, we have this

1 load-following capability at the ISO, it follows all the
2 supplemental energy dispatches, and so you are moving a lot
3 of generation in a fairly short amount of time as you look
4 at some of these large energy ramps.

5 Regulation people think about is all this 4-second
6 data going up and down, up and down, and you're driving
7 everything up to control frequency, but it is much more than
8 just frequency, you're also trying to manage the ACE or Area
9 Control Error on the interchange, and this is a particular
10 picture of the signal of the actual energy component that
11 goes into the regulation signal. And, as you can see, it
12 doesn't go back and forth over zero every four seconds or
13 every five seconds, or even every 10 minutes, it literally
14 spends a significant amount of time off of zero, which means
15 that the regulation units are providing a significant either
16 absorbing energy or providing energy, which is a problem
17 when you start looking at short-term energy storage. So, if
18 you've got a five-minute, 10-minute, 15-minute energy
19 storage device that is trying to provide that regulation
20 capability, it's going to run out of energy. And so this is
21 part of the problem is, as you look at those overall
22 regulation signals that are coming, and so forth, this is an
23 issue of how much energy does the storage devices have to
24 actually provide. And you can see, there are periods where
25 this - this was from October of last year - periods where we

1 were down almost 400 minus and almost 400 plus in terms of
2 the regulation energy component that is going up and down,
3 as well as the frequency peaks. There are those that say,
4 well, let's just carve out the frequency piece, but if
5 you're from the ISO dispatch perspective, that's way short
6 of the kind of resources that you need, you can't do just
7 frequency. If you just did frequency, you could have a
8 little frequency meter on your device, and whatever, and you
9 could run it up and down, but it doesn't really give you the
10 kind of control signal that you absolutely have to have if
11 you're going to meet the NERC control performance standards.
12 So, you have to deal with the energy piece, as well as the
13 frequency regulation piece.

14 So, some of the highlights of what we did, we
15 actually simulated about 250 different generators in detail,
16 and what their ramping capability, the ability to move
17 within the hour, we put in all the 4-second dispatch
18 signals, and we also put in all of the variability that you
19 get out of solar and wind generation, and looked at all the
20 ramping and so forth that is going to be within those areas.
21 And the thing that is interesting, we also not just modeled
22 California, but we also included the inertia and the import
23 capability coming throughout the whole Western
24 interconnection, so we have the inertia components of that,
25 and about half of the study effort was to make the model

1 simulate the way the real system worked, so if you took a
2 real day, with a real big generator trip, and looked at the
3 variability and things that happen, you'd like to have your
4 mathematical model produce the similar type results, or very
5 similar results, as to what the real system did. And the
6 thing that's interesting is mathematical models have
7 absolutely perfect response, and the Western Power Grid is a
8 little less than perfect, and so what we learned to do was
9 to put some inertia of slowdowns and some feedback loops and
10 things that would slow down the mathematical model so it
11 didn't act faster than the way that the whole Western Power
12 Grid does. Again, this is the time domain periods that
13 you're looking at, and so the analytical piece is basically
14 looking at the second-to-second, minute-to-minute, and out
15 to about an hour type variability. If you're looking at a
16 big energy shifting, then, of course, you go into basically
17 a production costing model.

18 The KERMIT tool, as I mentioned, did represent the
19 inertia from all the other parts of the Southwestern Area of
20 the United States, the Western part, Colorado, as well as
21 the Pacific Northwest. At that time, because the ISO was
22 also, you know, had the data for the whole Western Grid
23 because we were doing the - I can't think of the word -
24 anyway, the coordinators for the WCC for part of the system
25 - the Reliability Coordinators - I couldn't think of the

1 word - we also had the data on all these interchange data
2 and so forth, so that gave us the ability to do a very
3 thorough evaluation of the system and, again, as I said,
4 this is a big model for all the different parts.

5 Because we had a limited amount of time, we could
6 only look at summer, fall, winter, spring type days and do
7 snapshots of those particular days and do them in detail,
8 and then, of course, we looked at 2012, which was our 20
9 percent scenario, and also 2020, and again, in 2020, what
10 we're looking at is a low amount of concentrated solar
11 systems and different amounts of wind, and trying to put
12 those particular scenarios together. Was this the perfect
13 way the system is going to build out? Probably not, and
14 nobody would ever guess perfectly as to the way these build
15 out. So, this was trying to put some ranges and extremes
16 into the system as we looked at what those look like.

17 For the wind generation, then, we picked some days,
18 those specific days we had picked which was the July,
19 October and February, and basically what we would do was
20 scale those up for the different pieces. So, whatever you
21 had for north of Path 15, south of Path 15, as your specific
22 data, it was simply doing a scaling up to the larger amounts
23 of 6,000 to 10,000 to 13,000 amounts of wind, and the
24 concentrated solar. We had a very limited amount of data,
25 of course, there was only at that point about 400 megawatts

1 of concentrated solar, which we escalated up shamelessly to
2 a thousand, to 3,000, to actually up to 7,000 and 10,000
3 megawatts of concentrated solar. Again, you would get some
4 diversity, but you have to remember, a lot of the
5 concentrated solar will be built out in the Mojave area, and
6 so you do not probably get as much diversity as you would
7 get from PV. So, if you had PV in the north, PV in the
8 south, PV in San Diego, you'd get a lot more solar
9 diversity, concentrated solar is going to be in those areas
10 down in the southwest where there are lots and lots of sun
11 and very low cloud cover, even if you import some of the
12 concentrated solar from Arizona, the time shift is fairly
13 insignificant for when it actually ramps up. And even if
14 it's way out of Colorado, the time shift is only an hour,
15 and so whether it's ramping up at 7:00 in the morning or
16 6:00 in the morning, it is still - it's not a big time shift
17 that you're going to get on the solar. PV, as I said, we
18 had a limited amount of PV. The expectation is that you get
19 a lot more diversity, it doesn't ramp the same way, it has
20 more of a hyperbolic shape, and of course we're looking at
21 3,000 megawatts of PV. So, you start putting all of those
22 together and you get pictures that look like this, and so
23 you see, like at 8:00 in the morning, the wind has fallen
24 off, you're down to about 2,000 megawatts, and the solar
25 takes off and does this huge ramp up to, you know, 6,000,

1 7,000, 8,000 megawatts within a few hours in the morning
2 period. It turned out, as part of our simulation study,
3 then, that the big ramps up - and again, the big ramps down
4 at the end of the day, when the sun goes down, the solar is
5 gone. And, so, as you look at all of those big ramps, that
6 became one of the dominant factors in our simulation
7 studies.

8 Again, this is a picture of what the - the blue
9 squiggle across the bottom is basically what happens to your
10 ACE, or Area Control Error, as you get these larger and
11 larger amounts of renewables ramping in and out, and you can
12 see the ACE in this particular case went down in the morning
13 to a minus 2,000, and at the end of the day, when the solar
14 ramps out, our import, or the amount of energy that you are
15 needed, the ACE goes up well over 2,000. So, you see some
16 pretty big variables, and the fact that they extend for not
17 just seconds or minutes, but they're out there for almost an
18 hour, really is going to draw a lot of ramping of energy
19 resources and, so, those fast gas turbines and energy
20 storage devices are going to really be challenged because
21 there is a lot of energy to move in a fairly short amount of
22 time with these kinds of pictures.

23 So, this is a picture of the high solar type picture
24 and then this is one with four hours worth of energy storage
25 vs. one hour worth of energy storage vs. - one of the things

1 we did with the model, by the way, was we told the model
2 they could have an infinite amount of storage, so you start
3 out with saying you can use whatever you need, and then your
4 ACE, then, becomes this little green bar across the bottom,
5 and you perfectly meet everything that you have to do, and
6 then you say, well, "Okay, how much did the model actually
7 use?" And then you start ratcheting back to, you know, four
8 hours, three hours, two hours, and then you watch what
9 happens. And you can see, in this particular case with the
10 big red line, even one hour's worth of energy storage really
11 did not work, two hours helps a lot, and the four hours made
12 it perfect. So, certainly, the two hour may be a credible
13 economic level of storage that you're starting to look at,
14 at least that's what we were seeing as part of these
15 simulation studies. Again, this is an April day. One of
16 the things that Udi mentioned is the challenges we have in
17 the spring time with a lot of units are offline, the
18 renewables are going to displace most of the gas-fired
19 generation, you will still have your hydro systems on, but
20 you have very little margins left in the springtime for
21 units with lots of inertia and lots of ramping capability.
22 So, the periods that are going to be real challenges are
23 probably the shoulder months, spring and fall. Summer, you
24 have everything turned on, and so you have got lots of
25 capability of things that you can move, and so you may have

1 your 20,000 megawatts of regulation available in the summer,
2 but in the springtime, you've got a lot of units off for
3 maintenance, and you have very little room left; if you've
4 got the wind blowing, maximum, and of course the solar is
5 starting to come on as you get into those warm days of May
6 and certainly in early June. So those will be interesting
7 periods as you look at the different seasons and the things
8 that you have to do.

9 One of the things we had to do was try to figure out
10 what units we would actually have on as we moved out to 2020
11 and, again, we had the same problem that the ISO has talked
12 about, is that you get a lot of your units are displaced.
13 So, what are you going to de-commit? And so, we didn't have
14 enough time to run all of the production simulation models
15 that we would like to have had, so we ended up with what we
16 call the poor man's de-commit, so you take the oldest units
17 with the highest heat rates and say, I bet those are the
18 ones that are going to be forced off, and so, as one way of
19 getting there, is you start knocking off those and down the
20 list until you have just enough thermal units left on to
21 meet your basic requirements, and then you make room for all
22 the renewables that are coming on. So, that was our
23 particular way of going about it and, you know, we thought
24 it made a reasonable level of having the right amount of
25 units on.

1 So what we learned is that this particular
2 independent study really came through in validating other
3 studies that the ISO was independently doing, so that we
4 were looking at increases in regulation up to as much as 800
5 megawatts during some periods, and as we went to the year
6 2020, it looked like 1,600 megawatts of regulation would be
7 required. And, again, that fairly validated other types of
8 studies, so that was reassuring that the KERMIT type model
9 we were using was on the right track.

10 Again, we did not put in - you know, one the things
11 that was criticism in the study was that you'd say, well,
12 gee, Mike Gravely, you can certainly forecast what time the
13 sun is going to come up, you know, the ISO should be able to
14 forecast when you're going to see that big solar ramp coming
15 on in the morning, and start moving units in the right
16 direction, and so forth, so that you've made room for it, so
17 you don't have to use quite as much storage. And that's
18 probably true, and you can forecast pretty accurately the
19 time the sun is going to come up, and you can forecast when
20 those units will ramp. The biggest thing we found with
21 concentrated solar, it would go from essentially zero or
22 slightly negative as they warmed up the plant, to its full
23 output in less than an hour, and so those were fairly large
24 ramps. Now, the question is, if I forecast, and you know,
25 Jim Detmer says, "Well, what time is the sun going to come

1 up, are we going to see these?" And I say, "Well, it's
2 between 7:00 and 8:00." And so, we set up the system and,
3 lo and behold, we had some unexpected cloud cover, and it's
4 an hour or two hours late. What happens then? Do you have
5 enough other resources you can call on to cover that
6 shortage? And what do you do? And so the forecast error
7 and how much reserves you have to carry, and so forth, is
8 always going to be an essential part of doing some of these
9 studies.

10 Another part of it that we would love to include in
11 the future is, okay, what loads could be moved at the same
12 time, that would only have to move for 15-20 minutes, which
13 would slow down the rate that you'd have to move some of the
14 thermal or other hydro, and give you a little time for those
15 units to catch up, so there's more things to be done.

16 Again, we did not - we modeled the pump storage units as
17 either a generator or a load - if you're doing these studies
18 in the future, what you'd like to do is take compressed air,
19 pump storage units, and so forth, and do the actual more
20 detailed modeling so you can actually show what is the
21 turnaround time. So, if I'm going to go from a generator to
22 a load, you know, to pumping, or I'm going from the pumping
23 mode and I want to turn around and go into generation time,
24 do I do it 15 minutes, 20 minutes, what kind of time lags,
25 and what are the impacts of particularly compressed air

1 energy storage? How much do I have to count on that thermal
2 storage to heat the air back up, coming into the units, and
3 so forth? So, there are new additional kinds of modeling
4 things to be built in those areas. The other thing we were
5 asked to look at was, well, how effective is storage vs.
6 just buying another combustion turbine. We've all heard
7 that gas prices are going to remain low, we now have twice
8 the amount of gas of Saudi Arabia's oil, so, you know, gas
9 prices apparently are not going to escalate. So, you say,
10 "Okay, we can still do it with a gas turbine," and that's
11 true, but what we've discovered with this is that, because a
12 energy storage device can go both positive and negative,
13 where a gas turbine basically ramps up or it ramps off, it
14 turned out that about 50 megawatts of storage was about
15 equivalent, it got the equivalent effect that you would get
16 with 100 or 110 megawatts of combustion turbines. Again, if
17 you wanted to meet greenhouse gas requirements and so forth,
18 you're going to find that the storage is the more effective
19 solution.

20 This is, I think, just a summary of some of the
21 other - of the data that we've already talked about in terms
22 of how much storage at a watt, and then, again, a graph of -
23 you can see the 3,000 megawatts of storage, man, it solves
24 everything - it's expensive, but it does solve all the
25 problems with ACE. The 2,000 megawatt helps mitigate it

1 some, and particularly during some of the periods, but it's
2 not the perfect solution. Again, this was another summary.
3 The other thing that was interesting that we discovered is
4 that, not only do we have ACE problems, but we also started
5 to see a deterioration of the ability to control frequency,
6 or to meet the frequency control standards that are set by
7 NERC. The deterioration was not large, we didn't violate
8 the standards, but it certainly was going the wrong
9 direction, and there was a significant degradation as we
10 went down to, you know, in the 150's and 160's, where we
11 normally are up in the 180's and 190's percentage of meeting
12 those standards. So, I think this is just a reiteration of
13 one of the pictures that I had. So, policy recommendations,
14 one of the things that is interesting is the storage tends
15 to be very fast, certainly the lithium batteries and other
16 types of things will ramp from min-to-max in basically a
17 second or less, so there is - and the question, then, that
18 is always posed is, well, is there an additional premium or
19 a benefit from the fast storage? One of the other studies
20 that has been pursued is the idea of putting a storage unit
21 at a generating plant, and then, as the ISO sends out its
22 signal, that you can actually do a decomposition of that
23 signal at the plant, and take the fast regulation piece and
24 put it into the storage device, and take the slower, larger
25 energy pieces and put it into the generating unit, so you

1 have to move the generating unit less, and you take
2 advantage of both those type systems. The large generator,
3 then, also provides the missing energy piece that has a very
4 limited amount that can actually come out of the storage
5 device. So, that looks potentially interesting as one of
6 the ideas of pursuing that. And we certainly see validation
7 of the stuff that Udi was talking about, of increasing the
8 amount of regulation. The problem we see now, at this
9 point, if you looked at the latest regulation prices, even
10 though the ISO pays separately for reg-up versus reg-down,
11 if you took the numbers for the last three months of, say,
12 August, September, October of this year, and you added the
13 reg-up, reg-down, prices and you did the averaging, the
14 average turns out \$8.65 -- \$8.65 for regulation is probably
15 not going to pay very profitable for an energy storage
16 device. The East Coast, other places, seem to be more in
17 the \$30.00 - \$40.00 range, so regulation looks much more
18 interesting to Beacon Power back on the East Coast in New
19 York, and it's probably a tough one to pencil out yet on the
20 West Coast with that kind of number, but it's interesting.
21 As the amount of regulation that we have to procure goes up,
22 is that going to drive up the price? Perhaps, but there
23 seems to be a lot available. Anyway, more things to be
24 done. Was this a perfect study? No, it wasn't. We had
25 limited amount of data that we looked at, but we think we

1 certainly validated the fact that we have a new model that
2 we can use for the intra-hour variability studies. And so,
3 I think the goal was to understand the impact to renewables,
4 we've really, I thought, pushed the envelope a lot, and the
5 concept, too, of using new AGC algorithms is something we'd
6 like to promote, and the idea of having separate kind of
7 loops for how energy storage is used, and so forth, will go,
8 I think, a long way for providing the better solution. And
9 priorities for future work is, again, we'd like to see more
10 development, more days that we test, we'd like to put in the
11 Auto-DR piece, and we'd like to extend it out into more the
12 distribution type system areas and look how the whole
13 complement of Demand Response and energy storage are played
14 together. I think that's it. And so, we certainly proved
15 that energy storage is viable, it can do some fairly
16 interesting things, whether it is financially going to make
17 it work with \$8.65 for regulation, probably not, but there
18 are other things it can do. Thanks.

19 MR. GRAVELY: I'd like to give a chance - so for
20 anyone in the room here, we'll start first in the room here,
21 give them a chance since we have some ISO experts here to
22 answer questions, and we're talking about the primary focus
23 today is Grid support. I'd like to throw it out for the
24 audience, if you'd just go up to the mic and ask your
25 questions so people on the phone can hear you, please. The

1 mic should be on, go ahead.

2 MR. SCHAINKER: Yes, it is. My name is Robert
3 Schainker with the Electric Power Research Institute. First
4 and foremost, these last two presentations were fantastic,
5 thank you, gentlemen, for doing excellent work and just to
6 show us that we need more work to be done, that is for sure.
7 My question relates to the situation that there is a lot of
8 transmission constraints in the state, as well, and I'm not
9 sure to what extent, and that is my question, you included
10 transmission constraints in all those issues, that there's
11 so much ramping and regulation going on at different times
12 of the day in these predictions, it would seem that maybe
13 you have some views or observations about transmission
14 issues.

15 MR. HAWKINS: Yeah, for our particular study, we did
16 not include the transmission constraints, what we basically
17 did is a system-wide study, and certainly in other work that
18 we've done, we've looked at the fact that, if you have
19 regulation units that are behind some kind of transmission
20 constraint, you may not get all the regulation range that
21 you may think you're going to get. There also were times
22 where the amount of - the impact of moving units that are on
23 regulation, off of their energy subpoint, and then leaving
24 them up there for a period, also exacerbated the fact that
25 you had transmission all resolved they had with the energy

1 schedules, and lo and behold, I take some unit out of
2 regulation and I move it up 50 megawatts, and then start
3 moving it, you know, during the hour back and forth there,
4 and I no longer have an optimum transmission loading pattern
5 anymore, and so there are some really other interesting
6 constraints that one has to look at in the future. In terms
7 of optimum location of, for example, energy storage, one of
8 the things that we've kind of come to the conclusion is that
9 the closer you get to load, probably the better off you are,
10 but if you're working on transmission, you're much better of
11 looking at, say, a congestion point where a number of
12 renewables all come together, and so, if you are looking at
13 some major transmission point on north/south transmission,
14 and trying to mitigate transmission congestion on path 15 or
15 path 26, the closer you had energy storage - a large energy
16 storage - to those particular locations, you could do some
17 fairly interesting thing with transmission. That was beyond
18 the scope of this particularly study, but has been looked at
19 as part of other studies.

20 MR. SCHAINKER: Okay.

21 MR. HELMAN: So, neither of the studies that I
22 mentioned has a detailed network model, but the 33 percent
23 study has a WEC-wide model on a zonal basis, and it will
24 show some results of, if you reserve capacity on the
25 California power system for integration purposes, what

1 impact that has on WEC-wide flows at that level of
2 aggregation. So, yeah, it's not as detailed, but we
3 certainly have as part of our research agenda, to move on to
4 more detailed network models in the next round.

5 MR. SCHAINKER: Okay, thank you very much. Very
6 very interesting.

7 MR. GRAVELY: Any other questions? Okay, well,
8 thank you very much, gentlemen. We appreciate it very much.
9 So, we will now move into some of our more specific ones,
10 and John Minnicucci is going to talk a little bit about
11 SCE's strategy for storage and their activities, and we'll
12 be hearing later about some of their projects.

13 MR. MINNICUCCI: All right, let me test this thing
14 out real quick. Perfect, all right. It's great, I work in
15 Advanced Technology and I can't figure out how to run this
16 slide deck. Anyway, good morning, everybody and thank you
17 for having me here. I appreciate the opportunity. I've got
18 a lot of stuff to go through and a short time to do it, so
19 I'm going to move through this stuff pretty quickly. If you
20 have any questions, I'll be here all afternoon, as well as
21 Alex Morris, who is setting in the back probably hiding at
22 this point, any questions, you know, feel free to ask us,
23 we'll give you our cards and whatnot.

24 All right, with the short presentations, I like to
25 provide an Executive Summary, some key take-aways. SEC has

1 a long history with energy storage. We approach it from the
2 technology standpoint and from the strategic standpoint and
3 what can the technologies do and, you know, what do we need
4 them to do. Our approach to energy storage is from the
5 perspective of system needs and applications, as opposed to
6 just the technologies. SCE, like the CAISO, is technology
7 agnostic. You know, whatever works and whatever hits the
8 right cost point is a thing that we definitely want to use.
9 Energy storage, obviously, is a broad category of
10 operational uses and technologies, you've got everything
11 from super capacitors, very quick acting, to large-scale
12 pumped hydro, and it's a huge huge category. And then, I
13 guess the primary challenge facing us is, okay, well, what
14 are the best technologies? What are the specific and
15 practical uses that are cost-effective? As I said, we take
16 a bi-directional approach to things, we look at it from the
17 technology standpoint, which is what can technology do, and
18 we also look at it from the strategic standpoint, what do we
19 need it to do? Historically, we had a Chino Battery
20 Project, which was a large scale 40 megawatt hour project we
21 did about 1988. We found that the technology works, and I'm
22 looking here at Mr. Schainker, did the work with EPRI and a
23 whole host of other partners, found the technology works, it
24 just wasn't cost-effective, and so it wasn't something that
25 became deployed. You know, where are we at today? Well,

1 you know, those types of things might be cost-effective
2 today. Our EV Tech Center, I'm sure that most of you have
3 heard the EV Tech Center, it's something we started in 1993,
4 and we've tested a whole host of electric transportation
5 technologies and battery technologies for home energy use.
6 It's the SCE facility that President Obama visited last
7 year, that was a big plus for us, that's the first time a
8 sitting President had visited an SCE facility, and we were
9 very proud to have hosted him. The Tehachapi Storage
10 Project, I'll talk about on the next slide, as I will the
11 revised Smart Grid demonstration. So, let's jump to the
12 strategy side.

13 Understanding what the technology can do will really
14 help us to look at, okay, well, is it a potential solution?
15 Is this something we can use to address a distribution
16 problem, a transmission problem? Is it something our
17 customers might be able to use for interruptible power or if
18 they want to do some market arbitrage, or if they want to
19 supplement the solar on their rooftops, you have to look at
20 the application, not just the technology. And then, if you
21 look at bullet point 3, storage is a huge huge category,
22 it's not something that Edison can do on its own. You know,
23 we need to work with folks like EPRI and the CEC, the
24 Department of Energy, CAISO, with vendors, A123 is one of
25 the vendors on our Tehachapi project, it's a big issue and

1 if we don't work together and collaborate, it just takes
2 longer. I don't know that we get there without
3 collaborating, to be honest with you. And then, finally,
4 the last bullet on the strategy side, this is looking at a
5 roadmap. You know, there are so many technologies, there
6 are so many ideas, and there are so many potential uses for
7 the technology that, without a roadmap, it's really hard to
8 keep track of how everything fits together and who is
9 actually doing what. You know, PG&E, for instance, is going
10 the compressed energy storage up north. Well, I don't know
11 that SCE needs to do one of those when we've got our sister
12 utility up north doing it with EPRI. And I believe it's
13 also co-funded by the CEC. So it's just one of those things
14 that we, again, need to work together and keep track of how
15 all these things fit.

16 Our primary storage R&D efforts, I'm hoping that
17 Chris Villareal is still on the telephone because SCE did
18 sign the contract with the Department of Energy, yeah, we
19 are very very excited, the Tehachapi Project is moving
20 forward. Again, that is a utility scale lithium ion
21 battery, we're going to use that for, I think there are 13
22 different capabilities that we think we can use it for on
23 the Tehachapi system for wind integration, and whatnot.
24 Very excited about the project, cannot wait to get that
25 thing moving. The next project is the ISGD - I'm sorry, we

1 call it the Is Good [ISGD] project internally, it's the
2 Irvine Smart Grid Demonstration, and as part of that
3 project, we have a large transportable battery system or a
4 battery on a trailer. We want to test that system for
5 distribution purposes. If you have a circuit that needs
6 help, you know, during a summertime peak, it may need
7 upgrading, there may be different customers that come onto
8 the systems with, you know, either PV or whatever, that
9 change the dynamic of that particular circuit. We think
10 that we can use this type of technology to move in and keep
11 serving customers reliably until we can go out there and
12 actually upgrade the circuit to meet future needs.

13 Community energy storage - this is not a mobile
14 energy storage device, this is something that we would put
15 at a distribution location and, again, this would help with
16 customer installations, either things that are using
17 electricity differently than they currently are, or things
18 that are feeding back like distributed energy resources,
19 photovoltaic's and whatnot. So, we do see storage as
20 playing a pretty key role. Obviously we're looking to test
21 it. And then you get down into the residential home energy
22 storage, you know, how is the storage going to work with the
23 home area network, with plug-in vehicles, with the solar
24 panels, all of this stuff has to work together if it's going
25 to be a serious solution, you can't just have one thing work

1 and harm all the other things. So, that is our Irvine Smart
2 Grid demonstration.

3 This slide is the slide that I would like to have
4 flashing and, you know, burn into everybody's retina because
5 the needs and policy goals drive solutions. You have
6 changes to system inertia, you know, the once-through
7 cooling, don't know exactly how that is going to impact
8 things, but we expect that it will impact things very
9 significantly. What are the tools at our disposal to
10 continue providing power to our customers reliably? Well,
11 we think storage might be one of those types of tools, but
12 that's a big issue to solve, so that's just an example of
13 how policy drives more than technology drives. Again, we
14 want to identify potential solutions, there are a whole
15 number of solutions for any one problem, we want to
16 understand what all the potential solutions are, and then
17 test those solutions. Obviously, we're not going to do a
18 Tehachapi style demonstration for every particular
19 deployment that we want to do, there are others that are
20 doing these types of demonstrations, and we hope to learn
21 from that, but we do want to understand, you know, what is
22 the capable - testing proposed solutions. After you do your
23 testing, obviously you want to communicate your findings.
24 The thing that is great about doing a DOE or CEC-type
25 project, or an EPRI project, is the information is made

1 pretty much publicly available, and that helps all of us to
2 understand, you know, what the state of the technology is,
3 where things are moving, what works, what doesn't work, what
4 particular applications these things work for. I think it's
5 very important to have that open innovation. And then, you
6 know, the final is you need to look at the results, do a
7 cost-benefit analysis, and really - this may be the greatest
8 technology in the world, but if it costs 50 times more than
9 the benefits, well, I don't know if you go with that. Now,
10 it's really difficult when you're trying to solve a policy
11 problem because, you know, the cost benefit really - I don't
12 know how much that plays when you're ordered to do
13 something, or you're trying to keep the system up and
14 running when rules have changed, or whatnot. But, anyway,
15 that's kind of how we look at policy and how policy drives
16 technologies.

17 Now, as far as just a barebones, cut and dry
18 approach to assessing energy storage, we identified the
19 operational uses and understand the technologies, this is
20 just basic stuff, you develop your practical applications -
21 applications are system specific, different distribution
22 feeders have different, you know, nuances. There are
23 different customers, there are different types of
24 distributed generation, there is a whole host of, I guess,
25 nuances that require us to do things differently for each

1 specific application. There is no one-size-fits-all on the
2 electricity system. You match the applications with the
3 technologies and, finally, you've got to evaluate it, you
4 know, what is going to make sense? Again, if you've got
5 something that is very very expensive, what's the impact to
6 California ratepayers? That's something that concerns SCE
7 and I'm sure it concerns the other utilities, as well. We
8 want to be able to do what we do, but we want to do it at a
9 reasonable price.

10 I'm sure that most of you have seen kind of how the
11 technologies work and what some of the uses are going to be,
12 so I'm not going to spend a lot of time on this slide. I do
13 believe this presentation is available on the CEC website,
14 so if you had any questions on where we think some of these
15 technologies might play, this is not an exhaustive list,
16 it's just an idea of how we see things working. And here is
17 kind of a look at the technology overview. Along the
18 vertical axis, you've got your discharge time, not just in
19 quickness, but also in duration. If you look at the lithium
20 ion, the yellow oval there, the reason we went with the
21 lithium ion battery at Tehachapi was that you could make it
22 bigger by stacking additional components, so you could get
23 your megawatt power up, and it's fairly quick in reaction
24 time. And it's also got a pretty good duration, as well, so
25 that's kind of why we chose that specific technology, as

1 opposed to some of these other technologies. It's what we
2 thought we needed for that purpose. But this kind of gives
3 you an idea of what technologies might fit what specific
4 requirements.

5 Practical Storage Applications - I've only got three
6 examples here, we actually developed 12, and if you wanted
7 to see those, we will probably put them up on the Edison
8 website and we can send that out to everybody. But, you've
9 got all different types of applications here, you know, the
10 first one is more of a generation application, you know,
11 you've got wind that blows at night, the peak is some time
12 during the mid-afternoon, so you know, what can you do to
13 make those two match? Or actually, honestly, I think it's
14 more of an economics discussion, you know, for the
15 generator. You can probably make a little bit more money if
16 you can provide that power at a better time. So, that might
17 be something practical that you can do with storage. Peak
18 shaving, you know, something more down on the distribution
19 level. You know, our distribution circuits, some of these
20 circuits are fairly old, and with all the changes to the
21 circuits and all the new technologies, you know, we think
22 that energy storage can help us to shave peak and maybe
23 avoid some congestion on our own systems, so, you know, we
24 see a practical application there.

25 Finally, at the end user, with people going solar

1 and all of the incentives and things that are out there, you
2 know, I forget who had said it, but the sun goes down at
3 night and there's no more solar. So you need some type of
4 storage application if you do want to be entirely off the
5 Grid.

6 Conclusions. Valuing energy storage is a key issue
7 for all of us, we need to know how much it is going to cost,
8 what works, how can we do this together. I think there are
9 a number of efforts that are going on. I think that, as we
10 do these DOE projects and some of the CEC projects, then
11 ISO, we'll be able to better understand how to go about
12 valuing these things and really identify what the best
13 technology is for which purpose. And then, obviously, at
14 the end of this thing, there is a lot of work that remains
15 to be done, and I think collaboration is absolutely
16 essential to getting it done. Questions?

17 MR. VARTANIAN: John, Charlie from A123. If you
18 could speak a moment about the study component, my
19 understanding is the CEC, even in advance of the DOE and the
20 State, had funded Edison to do simulations that helped to
21 establish some of the foundational characteristics and
22 requirements, if you could speak to how you're going to
23 extend that work?

24 MR. MINNICUCCI: Absolutely. The CEC did - they
25 actually funded two projects, one was with SCE to look at

1 its transmission system and to determine where we might -
2 where storage might be the best approach to addressing some
3 of the issues. Obviously, in the Tehachapi area, there is a
4 lot of wind resource that is variable and we identified a
5 specific substation that had the right square footage, had
6 the right - honestly, it had the right everything from all
7 the environmental issues, all the way down to what we could
8 do with the battery. Charlie works for A123, used to work
9 for Edison, and he helped us with some of that work. And
10 frankly, that study was the genesis of our proposal to the
11 Department of Energy. Does that cover it?

12 MR. SCHAIKER: Robert Schainker. Very good
13 presentation, thank you so much. I know that Edison is
14 literally a world leader in electric vehicles and obviously
15 electric vehicles have a lot of battery technology in them.
16 I thought maybe you may want to comment on electric vehicles
17 as what Edison might think about in terms of energy storage
18 and the Grid size to accommodate the electric vehicle
19 potential on loading, either people plugging in at work
20 during the afternoon, or at night when we would prefer them
21 to plug in to re-charge. I'm sure you're familiar with all
22 this.

23 MR. MINNICUCCI: Oh, absolutely. Right now, as I'm
24 sure everybody is familiar, the CPUC is actually holding a
25 rulemaking on exactly those topics. Electric vehicles are

1 coming to California. We believe there will be about 74,000
2 over the next - I think it is by 2012, in our service
3 territory. Our distribution systems, again, are not
4 necessarily made for that type of additional load, so we're
5 going to need some type of technology to beef up our
6 capabilities. We've done some very detailed assessment on
7 where we think the deployment, or where we think customers
8 are going to purchase vehicles and plug them in, and we're
9 looking at prioritizing upgrades to those systems, which
10 will include everything from upgrading transformers, which
11 are not going to get a chance to cool off at night because
12 we're hoping the vehicles are going to charge at night and
13 make use of some of that wonderful wind energy production,
14 and also, as I had talked about with the distribution level
15 storage, I think that is something where I think it is going
16 to be essential to helping us meet our customer energy
17 requirement over the next few years.

18 MR. SCHAINKER: Thank you very much, John.

19 MR. MINNICUCCI: You're welcome.

20 MR. GRAVELY: Thanks, Mike. Hopefully the mic
21 system - we're now using two mics in here for speakers, for
22 those people online. We're getting a lot of feedback, so
23 hopefully it is better. Now, I'd like to bring up Doug
24 Divine from Eagle Crest Energy and we're now going to begin
25 to look at one of many presentations today, which is

1 technology specific, very large storage, and, again, one of
2 those technologies that we see as on the horizon.

3 MR. DIVINE: Great, thanks, Mike. I'm Doug Divine,
4 CEO of Eagle Crest Energy, a pump storage developer. In
5 addition, I have two of my colleagues from the National
6 Hydro Association, Don Erpenbeck of MWH and Rick Miller of
7 HDRDTA here to help talk through some of the issues on
8 advance pump storage, to assist with renewable integration,
9 grid reliability, and renewable load shifting.

10 We see pump storage as one of several technologies
11 that can partner with variable energy resources, but right
12 now, pump storage is the only commercially proven great
13 scale energy storage technology from 40 megawatts to over
14 2,000 megawatts. So, existing pump storage projects in
15 California such as Helms and Castaic were built to
16 complement nuclear plants and off-take excess energy at
17 night. Today we will discuss the changing uses of pump
18 storage to meet today's requirements.

19 So this is a different version of that Edison chart.
20 What I've done, I've taken out the log-log because it just
21 makes it easier for me to look at. So, pump storage today
22 provides solutions, again, anywhere from 40 megawatts to
23 thousands of megawatts of energy storage, and is a part of
24 the solution going forward, and we're here to say that
25 wholeheartedly. Pump storage is probably the easiest of

1 these technologies to explain. Water flows from the upper
2 reservoir to generate electricity when energy is needed. We
3 pump water uphill when excess generation is available, at
4 reasonable cost. We're going to talk today about some of
5 the changes in technology, some of the new technologies that
6 make pump storage even more applicable to solving the
7 solutions of intermittent energy with renewable energy
8 resources. We'll talk about adjustable speed units, which
9 have very fast response times, and the ability to go very
10 low load operations, and it will allow for numerous cycles
11 per day, unlike some of the existing facilities, which were
12 designed to cycle once per day.

13 And now, Don Erpenbeck will talk about some of the
14 technologies, the advanced technologies, and the benefits
15 they will bring to the system.

16 MR. ERPENBECK: So this next slide, actually the
17 next four or five slides, we were invited in to NERC last
18 week to talk a little bit about what the capability of pump
19 storage really is, and one of the things we realized is
20 that people don't understand what the pump storage fleet is
21 doing right now. So, this shows the different types of
22 response times. The green line represents adjustable speed
23 machines, which are the new state-of-the-art technology, and
24 there are none of those in North America presently. The
25 black line represents single-speed synchronous generators,

1 and you can see that frequency regulation is much higher
2 with the adjustable speed machine, but the one thing that is
3 different with the adjustable speed is we can do load-
4 following and frequency generation in pump mode because we
5 can have an adjustable pump. An adjustable speed machine
6 with a 10 percent speed range, a 350 megawatt machine would
7 have about 125 megawatts of adjustable decremental range up
8 and down while it's in pump mode, where a synchronous
9 machine, once you closed the breaker, you're pretty much
10 fixed based on hydraulics.

11 This one shows the difference in operating range.
12 Now, the blue line is a synchronous machine, older machines
13 are operating above that rough zone from about 60 percent
14 gait up to about 100 percent, and newer machines where we're
15 replacing the runners, even at the older plants, are now
16 operating down in that 20-30 percent range, and they're
17 sitting down there basically idling, waiting to ramp up.
18 The adjustable speed machines give us a much higher
19 efficiency range across the board, it'll give us a 3-4
20 percent if we were running at peak efficiency all the time,
21 but since pump storage is not really dispatched on a
22 technical basis, but on an economical basis, it really could
23 be more like 10 percent in terms of total efficiency
24 performance and the difference between a synchronous plant
25 and a adjustable speed plant. And so you can see a much

1 wider operating range on the high end and low end. Machines
2 can operate in the rough zone, it's just that we require
3 some injection air, and so there is a little bit of a dead
4 ban sometimes for a lot of these older plants in North
5 America, that sort of sits in that 40-60 percent, and an
6 adjustable speed, we can really squeeze that down so that we
7 almost have none.

8 An adjustable speed pump storage machine is a
9 flywheel. We can run - these are large inertia machines, we
10 can run these as flywheels, we can give up speed in the
11 speed range and produce positive megawatts in the adjustable
12 speed mode, we can do it in synchronous condense mode, we
13 can do it in pump mode, we can do it in gen mode. We can
14 play with the frequency range to do what we need to. The
15 two graphs on the right represent the difference in a
16 transient situation over six seconds. The top one is a
17 synchronous machine, how it responded in Austria to an
18 event, and then the second one is what the adjustable speed
19 machine does to the voltage. And you can see the red line
20 is basically flat-lined in terms of the active response, in
21 terms of the seconds.

22 One of the things I want to talk about and mention
23 is the ramp rates. Pump storage projects right now are
24 ramping at between 5-10 megawatts a second, from those part-
25 load operations, that's the normal what they're doing in

1 California and Arizona right now, that is on unit basis. On
2 a plant basis, Castaic's six units can do 40-50 megawatts a
3 second, and they're getting called on on a regular basis.
4 when you talk about the KEMA study and transmission
5 constraints, their way that the grid is dealing with it is
6 by dispatching the pump storage very fast. And the
7 adjustable speed improves the frequency response and through
8 the power of electronics and a router and what it can do in
9 terms of frequency, and how fast it is. But the overall
10 performance is more of a hydraulic one.

11 The last slide on sort of technical performance is
12 mode changes. This is the fastest pump storage plant
13 response time plan in the world, it's in North Wales, called
14 Dinorwig, it's about 2,200 megawatts right now, and two
15 units are pretty much turned over to the transmission grid
16 at any one time. This project can go from full pump mode to
17 shutdown and generate in under eight minutes, from full pump
18 output to full gen output in under eight minutes. It does a
19 ramp rate of about 2,300 megawatts a second per unit, and 50
20 megawatts per second at a plant level. This plant is
21 basically the way they integrate renewables and generation
22 in the northern part of the UK, but you can go from spin to
23 generate, so synchronous condense to generate in 12 seconds,
24 from spin to pump. So this is a conventional synchronous
25 machine, this is not an adjustable speed plant.

1 So, now to sort of go to the future and what's going
2 on around the world. One of the things that is changing is
3 most of the pump storage projects that are being built now
4 are either utilizing existing reservoirs that already exist,
5 or they are closed loop systems, which means they're fully
6 self-contained, they're filled with a stream, or from ground
7 water, and they're very environmentally benign. Some of the
8 NGO's have even come flat out and said it in writing, that
9 they do not have an objection to most of these systems.
10 They would want to look at each one on a one-by-one basis,
11 but that they can support this type of renewable
12 integration. What is the rest of the world doing? Rick is
13 going to talk a little bit more about some of the specifics
14 about how they're integrating wind in Europe, but you can
15 see right here that the U.S. has 18,000 to 19,000 megawatts
16 of nameplate, but it's really closer to about 24,000
17 megawatts of pump storage, that is two percent of the U.S.
18 grid is currently pump storage. California has almost
19 4,000, about 3,500 megawatts of pump storage, of which the
20 first block of 400 was built by WR Gianelli in the '60s, the
21 second block was 1,500 megawatts at Castaic, was built in
22 the '70s, Helms was built in the '80s, and there have been
23 none since the mid-'80s, since Helms, but you can see there
24 is a little job in the U.S. for 40 megawatts down in San
25 Diego that San Diego County Water Authority, that very

1 bottom of what's under construction. So you can see in the
2 world, Europe has almost 40,000, Japan has almost 10 percent
3 of its grid, it's pump storage. Now, the right-hand graph
4 shows what's under construction, there are three projects
5 under construction in Spain alone due to wind integration.
6 There are two in Switzerland, there is one in Austria, there
7 are about 6-7,000 megawatts that are in early - will be
8 breaking ground here very shortly, they're not shown here as
9 under construction fully yet, but you can see Portugal,
10 Spain, Switzerland, with almost 2,000 megawatts. So, you
11 can see from this graph that the rest of the world - and if
12 you look at the European versions of these wind integration
13 studies, they all come back to hydro pump storage and other
14 forms of storage. They are complimentary to each other,
15 they're not the same.

16 So the pump storage trends in Europe, they are
17 building pump storage projects to integrate their wind; that
18 is the trend that is going on around the world. They're
19 looking at 20 percent wind integration and the ENSO area is
20 supporting large transmission projects to help reinforce the
21 interconnection of all these different pump storage
22 projects. So, Rick Miller here is going to introduce some
23 various aspects.

24 MR. MILLER: Thank you, Don. And again, to focus on
25 this, what's happening in Spain and what's driving the

1 development of grid scale storage in Spain is lack of
2 transmission interconnection with the rest of the European
3 Union. Spain and Portugal, the Iberian Peninsula, has a
4 very weak interconnection with the European Union, so
5 therefore they have about 14 percent of variable generation
6 and, as part of their grid, they're building three pump
7 storage projects today. They don't have any other options
8 for grid scale storage. What's happening in Denmark?
9 Denmark is used as a benchmark for wind and variable
10 generation integration. How does Denmark really work?
11 Denmark is a part of the North Pole, it doesn't do its own
12 balancing. And it has strong interconnects with Norway,
13 Sweden, and Germany. And it utilizes the conventional
14 generation, the conventional storage in Norway, to integrate
15 - there are 3,000 megawatts of wind energy. Here is
16 Denmark, you've got strong interconnects in Norway to the
17 north, and Denmark as a system is very inflexible, it is a
18 must run distributed generation system of central heating
19 plants, a very small number of large central generation
20 plants, and a very distributed wind pattern, but in a small
21 geographic area distributed around the country of Denmark.
22 And the way Denmark works, there is a 1:1 correlation with
23 energy flow over the power interconnections to Norway with
24 wind output. The red line at the top is wind output, this
25 is in the winter season where it's a high wind output

1 season, and if you have the - if you look here at the top,
2 you have high wind output, you have high energy export to
3 Norway, where you have low wind output here, you have -
4 Norway is re-importing - is exporting the energy back into
5 Denmark, so it is on a grid scale, it is utilizing the large
6 storage that is available in Norway and their
7 interconnection, so the message is, where you have not a lot
8 of flexibility in your generating system, you've got to be
9 connected to another flexible system in order to make it all
10 work.

11 The industry has been working with Bonneville Power
12 to help them figure out their challenges every day. This is
13 a relatively busy slide. The message here is, well, this
14 slide and this study will be coming out on BPA's website in
15 the next few months. To walk you through this, the top line
16 is load, the red line is variable wind, and the blue line
17 here is net load. This is what your non-wind assets within
18 the BPA Balancing Authority have to respond. This - and the
19 key point here is the rapid ramping that is occurring every
20 day on the Bonneville system. This is a day in June of
21 summer of '09, and this really validates the KEMA study,
22 rapid ramping of thousands of megawatts in an hour is the
23 future where you have thousands of megawatts of variable
24 generation. And then, of course, if you look at the high
25 ramping here on this day, where it's out of phase with load,

1 you have wind coming up, load dropping down here, the dark
2 blue line, your net load is your non-wind assets where they
3 have to be basically shut down in order to have the system
4 balanced. We integrate storage into it, this is the bright
5 green line here. What that shows is the re-dispatch of the
6 Columbia River system, you have a more stable power output
7 and greater grid reliability.

8 This is the U.S. market today for pump storage,
9 there are 40 projects, as Don mentioned. The bulk of those
10 are in the east. Here is the future. There are about 60
11 projects in front of FERC today for preliminary permits,
12 representing over 50 gigawatts of energy storage. The bulk
13 of these are in the Western U.S., again, driven by the
14 variable generation market opportunity, and the needs for
15 greater reliability. NERC's biggest challenge is in the
16 Eastern interconnect where we have very little grid scale
17 storage being proposed. NERC is very concerned about future
18 grid reliability due to the rotating inertia that will be
19 decommissioned -- potentially decommissioned -- over the
20 next three to five years. And I'll turn it back to Doug.

21 MR. DIVINE: Right. California clearly knows a lot
22 about pump storage, a rich history with pump storage with
23 projects like Helms and Castaic, and there is currently a
24 proposed project, 6,000 megawatts currently under
25 development in California. And among other things, the

1 development of pump storage here does assist with some of
2 the air emission issues, also, with the ability, again,
3 during periods of renewable over-generation to take that
4 off-peak power and deliver it on-peak with no additional
5 emissions, very beneficial. So, in building what the KEMA
6 report and some NERC studies, storage is a part of the
7 solution going forward for intermittent renewable
8 generation. And we believe that the new pump storage plants
9 using some of the adjustable speed technology can be a part
10 of that solution. As we talked about adjustable speed
11 turbines can at times act like a flywheel providing very
12 fast response. In addition, some of the utilities and
13 developers are looking at economically and environmentally
14 advantaged sites with reduced construction and reduced
15 environmental issues. And finally, as Rick talked about, in
16 Europe and Japan and Asia, pump storage is a part of the
17 solution being implemented today to deal with these kinds of
18 issues.

19 Of the eight projects currently being permitted in
20 California, we would expect at least a couple of those to
21 move forward in construction in the next four to five years,
22 providing in excess of 2,000 megawatts of capacity. There
23 are certainly markets in California for pump storage, we've
24 talked about that, but with the large capital costs of these
25 projects, there are certainly challenges in developing and

1 getting these projects actually built. I know policy will
2 be following on later, but just some topics to think about,
3 firm ancillary service markets, you know, we need long term
4 buyers. It's hard to build a 20 or 50-year asset on a five-
5 minute market. We need storage tax credits and incentives
6 for developing storage projects, including in the RPS,
7 certainly perhaps AB 2514 is a step towards that and we look
8 forward to working with both the Energy Commission and the
9 PUC on those issues, and believe that pump storage, along
10 with the other storage technologies can help us toward
11 moving toward a more carbon-free electric generation market.

12 MR. GRAVELY: In the interest of time here, thank
13 you very much, we have time for one or two questions in the
14 audience. Does anybody here have any questions? Come to
15 the mic, please.

16 MR. CUTTER: I have a quick question -- Eric Cutter,
17 E3 -- on whether all the new hydro facilities are sort of
18 automatically adjustable speed drives, or if there is a cost
19 benefit tradeoff you're looking at in terms of incremental
20 regulation and that kind of revenue to make the extra cost,
21 adjustable speed.

22 MR. DIVINE: I think projects that are currently
23 being looked at in the U.S. typically will have maybe some
24 adjustable speed and some synchronous speed in a single
25 facility. I know that a number of the projects in Europe,

1 they're either adding adjustable speed to an existing
2 facility, or they're looking at, again, adding maybe a 2+2
3 configuration, you can get a lot of the benefits of
4 adjustable speed with not making the whole unit adjustable
5 speed.

6 MR. GRAVELY: I'd like to add one thing here. We
7 haven't talked about it, and of course, this technology with
8 the length of storage, as we knew about the night time wind
9 here in California, that could be an issue in the future,
10 so, as we talk between now and next summer, or next spring,
11 we do want to look at this load shifting. And some storage
12 technologies like this one have inherently, you know, 6, 10,
13 12, 15 hours, some storages have 15 minutes to a half an
14 hour with different applications, so we do want to look at
15 those, so where it is not specifically grid support, it is
16 specifically renewable integration. So, we do want to
17 address and talk about that, and maybe later try and see
18 what the value of that when you look at a project that has
19 both, you know, how you equate the value both, for instance,
20 if it's just one or the other. Thank you very much. So,
21 hopefully those on line, using two mics is more helpful than
22 just one, we're trying. Now, I'd like to turn it over to
23 another technology that we're going to talk about again,
24 this one here is one of the results of the ARRA funding, and
25 we've talked about a single large project, so now we're

1 going to talk about a distributed project, or a project that
2 takes lots of distributed energy and controls it as one
3 large project. So, Frank Ramirez from ICE Energy is now
4 going to give us a presentation on how we can take
5 distributed resources and turn them into a one single
6 controlled grid resource.

7 MR. RAMIREZ: Thank you very much. We're really
8 happy to be here today and for a number of reasons. In the
9 first place, we are the redheaded stepchild, we don't appear
10 in many of the graphs that you've seen because, while a very
11 powerful storage technology we are, we don't store
12 electrons, we store energy. And we store energy and produce
13 work directly, and do so with round trip efficiencies of 1:1
14 or better at the site. As an electro thermal technology, we
15 are unusual in this space, and we are purpose built to do
16 but one thing, and one thing alone. Before we get started,
17 I wanted to thank so many of you in the audience that are
18 really responsible for our being here today - KEMA, EPRI,
19 E3, and many of the members of the California Energy
20 Commission and Public Utilities Commission who, over the
21 last eight years, have sponsored our work. We are here
22 today \$100 million in the red, having devoted a great deal
23 of time, energy and resources, to bring forward this
24 resource that is now ready for prime time. That resource is
25 the Ice Bear pictured before you, is in fact the technology

1 that Art Rosenfeld referred to as the one technology that
2 does not game the system, that creates value based on its
3 ability to shift energy consumption on a permanent basis,
4 leveraging whatever resources are available during off-peak
5 periods, and offsetting but one need, and that is the need
6 for air-conditioning comfort.

7 Our purpose today is to discuss what our features
8 are, but I think when you take a look at the projects that
9 we've done, you'll see that we are proven reliable, cost-
10 effective, Smart Grid enabled, and that we're ready for
11 large scale deployment today. Our benefits are not
12 dissimilar to the benefits that are provided by electrical
13 storage resources, or electrochemical resources, but given
14 the nature and the highly distributed nature of our
15 technology, we're also a driver of hundreds of California
16 jobs. As a proven technology that is commercially
17 available, we've accumulated more than 5 million hours of
18 field collected data and operational run time. We've been
19 piloted by 24 utilities over a seven-year period, we have an
20 advanced manufacturing plant in Hammondsport, New York. We
21 are executing today on a 53 megawatt utility scale contract
22 with SCPPA, and we've structured some extraordinary
23 partnerships in the industry, including those with OSI soft
24 PI, AT&T's 3G network, Trane, and Carrier, who are now
25 producing off of their production lines ICE ready rooftop

1 units that quick connect to our energy storage modules. The
2 benefits of distributed energy storage are such that, while
3 we typically think in terms of only capacity and energy, the
4 many benefits that can be imputed to storage are typically
5 not easily modeled and are handled by the models that
6 typically evaluate system resources. And for that reason,
7 we partnered with R.W. Beck and released in October a new
8 electric utility modeling guide that provides a mechanism
9 and a how-to manual for system resource planners, total
10 resource cost analysts, and integrated resource
11 professionals, to be able to evaluate the various attributes
12 of distributed storage, and those many benefits are captured
13 here before you. Suffice to say that existing models don't
14 do a good job at all of capturing value, and so many times
15 when we work with utilities, we're forced into a situation
16 where we're working inside of a particular silo, and what
17 we've had to learn is how to work in an integrative way
18 across the silos, in order to be able to bring different
19 groups within a utility to attribute the various levels of
20 value that, in the aggregate, provide a strong economic
21 support for distributed storage.

22 I mentioned that we are purpose built for but one
23 purpose, and that purpose is to reduce air-conditioning load
24 for six hours a day, every day, by complementing existing
25 energy removing resources that sit on commercial and light

1 industrial rooftops. As you can see from the slide before
2 you, cooling is about one-half of the commercial load and
3 commercial air-conditioning load extends beyond the utility
4 peak period. We've heard today that the value of storage
5 increases as it is moved along the delivery chain of energy.
6 There are various storage technologies that have a role,
7 depending on where storage is placed, central, or pumped
8 hydro at a central level, at a substation level a number of
9 different technologies, including flywheels. At the very
10 edge of the grid, we provide through phase change a storage
11 technology that removes from the grid for six hours a day
12 three phase inductive load on a permanent basis.

13 The graph before you is relatively self-evident, but
14 for those of you who have not seen this particular
15 presentation, we know that, and it is well understood that,
16 the entire electrical system is thermally inefficient.
17 During the heat of the day, before you pictured is a
18 representative case in Los Angeles, where it takes 140
19 megawatts of generating load to deliver a generating
20 capacity, in order to deliver 100 megawatts of effective
21 work at the site. Those losses, those Exergy losses, are a
22 function of grid adjustment losses, off-peak generation and
23 adjustments, reserved margin requirements, all of them that
24 are just losses in heat and thermal inefficiencies
25 associated with getting electricity from the point of

1 generation to the point where it is used.

2 Every two years, the California Energy Commission
3 publishes a comparative cost of central station electric
4 generation, and we've taken the data from this to plot two
5 important points on a graph that can best be looked at as
6 variable and fixed costs. On the upper left-hand corner is
7 a simple-cycle peaker, on the lower right-hand corner is a
8 conventional combined cycle plant. But bifurcating those
9 two points is a line that can be referred to as a grid
10 parity, or an efficient gas frontier, which essentially says
11 that anything inside of that frontier is cost-effective,
12 anything outside is not cost-effective. For purposes of
13 this particular presentation, our particular resource has
14 been placed on a relative benefit basis through a
15 methodology that has been validated by E3. The simple
16 conclusion is that we are cost-effective today without
17 subsidy. But in addition to the energy and capacity, which
18 was captured in the previous graph, little known is the
19 degradation curve for HVAC compressor efficiency.
20 Paralleling the efficiency that degrades in the performance
21 of a traditional gas plant where nameplate capacity degrades
22 as a function of heat, so too does a conventional air-
23 conditioner degrade as a function of heat. Energy demand
24 increases to maintain cooling and comfort. So, you get a
25 double whack to the system. At the hottest parts of the

1 day, not only do your generating resources degrade in
2 efficiency, the very cooling resources that sit on top of
3 buildings are degrading at a level that is almost
4 comparable. Conversely, when we deploy our technology, our
5 ability to cool a building doesn't vary as a function of
6 heat. Running a continuous 300 watts of energy to cool a
7 building with our stored energy in effect provides a
8 resource that remains stable as temperatures rise, the net
9 effect of which is that, unlike a generator that degrades in
10 efficacy as temperatures rise, our equivalent output to the
11 system increases as a function of temperature. Our
12 effective benefit to the system, then, on a 100 megawatt
13 deployment is the equivalent of 115 megawatts of benefit
14 with what a 15 or 20 degree rise in temperature.

15 Today we are executing on a project in Southern
16 California with SCPPA. As many of you know, it's a joint
17 powers authority with 11 municipal utilities and one
18 irrigation district. Today, we are executing on a 53-
19 megawatt project on what is the first phase of what we
20 expected to be a multi-hundred megawatt deployment of our
21 distributed resource.

22 Before you are a number of applications, we've
23 deployed approximately 200 units against this particular
24 engagement at this point in time, and expect to eventually
25 deploy as many as 6,000 units. As you can see, there are

1 some ground bounded opportunities for fast food, for box
2 retailers on the roof, fast food franchises. These units
3 mount directly on the roof in rooftop applications near or
4 within 150 feet of conventional RTUs. We've just done an
5 11-unit deployment on a Federal building on a new
6 construction. But our energy storage module is far more
7 than just the Ice Bear, what makes it a utility scale
8 resource is the number one rated Smart Grid communications
9 platform in the world. The Ice Bear, in conjunction with
10 its embedded real time control platform provides a cost-
11 effective, scalable resource that provides bulk storage in a
12 distributed manner, not central, but distributed. The
13 picture before you is one of the outputs that we provided to
14 the utility, that enables the utility to configure how it
15 gets the output from these many distributed resources. The
16 control dashboard provided to the utility allows control
17 measurement verification and customer defined reporting for
18 the utilities. It organizes and summarizes the results as
19 needed with the flexible navigation pane, and it's organized
20 by area substation theatre, or building level data. The
21 resources also tie directly into utility operations
22 providing dispatch and control. Scheduled changes can be
23 made on the fly in response to changing system conditions,
24 and we can apply different control strategies to one or any
25 or all a subset of other storage devices. Recent highlights

1 include a CSI grant of Sun plus Ice, together with sun power
2 target ice energy in KEMA and Sandia Labs. And I'll call
3 attention also to a first energy project with EPRI that
4 we're doing, a Smart Grid project in conjunction with
5 Staples in Howell, New Jersey.

6 Today, we have relatively significant opportunities
7 that we are in contract to conclude with Ontario Power
8 Authority, with American Electric Power, with Tucson
9 Electric Power, and with the Southern companies. We are
10 today proven, ready, cost-effective, and moving into the
11 market.

12 We also create a lot of jobs. A 100 megawatt
13 project generates approximately 300 direct jobs, paying
14 hourly wages in excess of \$60 million associated with the
15 building of these units, their installation, and their
16 commissioning. The various types of green collar jobs that
17 are created are depicted on the slide, and provide in many
18 instances economic multipliers locally of between four and
19 seven times. We'll argue that these jobs can and should be
20 in California.

21 Barriers with respect to our adoption - we'll be
22 providing written comments, these are high level comments
23 with respect to the barriers that we see, that are true not
24 only for us, but for all storage technologies, in general.
25 The lack of generally agreed upon cost-effective methodology

1 probably is tops among them. There are a lot of regulatory
2 regimes that don't yet fully consider storage, and there are
3 numerous externalities of environmental and other conditions
4 that are not captured, carbon being one, in terms of the
5 value that storage provides at a system level.

6 In summary, we request that the distributed energy
7 storage be included by the Energy Commission in the IEPR and
8 other relevant policy proceedings as a valuable utility
9 scale, cost-effective, renewables integrating, commercially
10 available resource. Thank you for your time.

11 MR. GRAVELY: Time for one or two questions.

12 MS. PEITTE: Mary Ann Peitte, Lawrence Berkeley
13 National Lab. Quick question about daily peak load
14 management and permanent load shifting vs. dispatchability,
15 if you could comment a little bit about that.

16 MR. RAMIREZ: The value that we provide to a utility
17 enables the utility to dispatch and control our technology
18 as they wish, it's been our finding and it's been the
19 conclusion of the utility, that their greatest benefit
20 inures from having us perform every single day permanently
21 shifting six hours of load; however, from the control module
22 that is embedded in our unit, we can also provide the
23 opportunity to offset other compressors for 15, 30 minutes,
24 or 45 minutes, allowing a control, even while they're
25 permanently shifting the load that we provide. The embedded

1 controller provides the opportunity for the utility to
2 dispatch and control other rotating pieces of equipment on a
3 building that they may wish to manage on a real-time basis.
4 While we provide them with the functionality to be able to
5 control each unit individually, it's been our experience
6 that their choice is instead to remove load permanently for
7 six hours every day, during a period that absolutely covers
8 their peak.

9 MR. WATSON: Dave Watson, Lawrence Berkeley Lab.
10 Can you comment on the baselines methodology and the
11 Measurement and Verification of this resource?

12 MR. RAMIREZ: Can you give me a little better
13 explanation of your question?

14 MR. WATSON: Well, in order to evaluate a resource,
15 you have to measure it and are you typically adding
16 additional sub-metering? Or are you using existing whole
17 building electric meters to measure the difference between
18 what it would have been if your device was not installed vs.
19 when it is installed, and when it's dispatched vs. when it
20 is not dispatched.

21 MR. RAMIREZ: Terrific. What we provide to the
22 utility is verification that the compressor to which we are
23 connected isn't run. We connect to the first stage
24 compressor in a rooftop air-conditioner. And the
25 verification that we provide to the utility is that that

1 compressor hasn't run. And depending upon the service
2 territory, each compressor has value of between 6 and 8
3 kilowatts that are not being consumed during that time
4 period, and our verification to them is that simple, that
5 compressor hasn't run.

6 MR. GRAVELY: I would like to point out, just for
7 purposes of today's discussion here - Frank, thank you very
8 much for the presentation - we hear the phrase "virtual
9 power plant," I think we've just seen a discussion of a
10 virtual power plant. I think the elements that they have
11 worked out, the logistics, the communications, and as Dave
12 Watson brought up, the verification process, is very
13 critical, it is a fact that we can have thousands of
14 distributed systems that can be managed by a single control
15 system, and you can verify what they do and don't do, it
16 brings a new opportunity for us to consider as we go forward
17 in the area of distributed resources.

18 So now I'd like to turn it over to Janice Lin from
19 the California Energy Storage Alliance, who has been very
20 aggressively helping California and was very involved in AB
21 2514, and represents many of the people here, as well as
22 other storage agencies throughout the country in trying to
23 advance energy storage in California.

24 MS. LIN: Thanks, Mike. Hi, I would like to thank
25 the Commission and Mike and Avtar for inviting me to be here

1 today, it is really great to be back up in Sacramento.
2 Let's see here, so Mike and Avtar asked me to talk about the
3 importance of energy storage to California's renewable
4 future. First a little bit of context. CESA, as we're
5 called, it's the other CESA, California Energy Storage
6 Alliance, we were founded in January of 2009, and our
7 mission as an organization is to expand the role of storage
8 technology to accelerate the adoption of renewables in a
9 clear, more affordable, and reliable electric power system
10 in California. We started out a few months ago with just a
11 couple of members, we're up to 28, and a couple more points
12 about CESA, we are technology neutral, so we represent just
13 about every storage technology. We are Agnostic as to type
14 of technology, we support all ownership models, and of
15 course, our focus is California.

16 One of the great things about being later in the day
17 is you present slides that everybody has already presented.
18 Here is a familiar chart that has been presented at least a
19 couple of times. What I did want to emphasize is that there
20 are many types of energy storage, and how we look at the
21 world of energy storage, it does include thermal, which is
22 this nice little gray overlay here on the top. Because many
23 folks, as we kind of go out in the world, you know, sort of
24 approach me and say, "Well, isn't storage just in R&D? I
25 mean, what else is there besides pumped hydro?" Well, for

1 starters, there is a lot of storage in the world, like
2 upwards of 125 gigawatts, more than 125 gigawatts installed
3 worldwide. Now, granted, most of that is pumped hydro, and
4 we love pumped hydro, soon you guys have to join our
5 membership, but there is at least several thousand megawatts
6 of other types of storage installed and operating
7 commercially today. And rather than spend a lot of time
8 because I only have 20 minutes, I just wanted to show you a
9 few pictures, some technologies here, you saw the Ice Bear,
10 Frank had a wonderful presentation. Down here in the lower
11 left corner is a Beacon flywheel, this is a three-megawatt
12 installation, but they have 20 megawatt installations under
13 construction now in the Northeast and the Midwest. Up here
14 in the right-hand corner is a 34-megawatt battery integrated
15 at a wind farm in Japan, a sodium sulfur battery, and there
16 are several examples of lithium-ion technologies. And down
17 here in the left-hand corner is a one megawatt hour battery
18 from Extreme Power that is integrated with wind on the
19 island of Maui.

20 Okay, so some of the drivers of storage, I don't
21 want to spend a lot of time, but it's important for context
22 that we understand there are many drivers of storage.
23 Renewable integration is one of them, and I understand that
24 is the focus of today, but we also - it's important to
25 remember that storage is a very key asset and a fundamental

1 part of the Smart Grid, and we have our inexorable peak load
2 growth and transmission constraints especially here in
3 California. Another key driver is that storage will reduce
4 GHG emissions, and I think it has been spoken about, and
5 Frank covered it, but what you show here on the chart is the
6 brown line is the emissions, this is tons of CO₂ per megawatt
7 hour of peaker plants, the aqua line is the sort of base
8 load combined cycle, and the idea is you can shift mode from
9 peak to off-peak in well-cleaned air. Okay, very funny
10 font, sorry about that. Here's a MAC/PC conversion.

11 So, shifting over to the benefits of California,
12 there are four benefits that we like to talk about really
13 big picture, one is that storage deployed in California will
14 create jobs for California, and I think Frank covered that
15 with some examples of job creation. There is a project in a
16 factory that has been announced, that is being built in
17 Southern California and LADWP territory. LADWP is also
18 installing through that same partner, it is a Chinese
19 company called BYD, have five or 10 megawatts, four-hour
20 system, to integrate with our wind farm out near Tehachapi.
21 So that is job creation happening right now; 2) energy
22 storage does support California's landmark AB 32 legislation
23 3) energy storage will help enable our achieving our
24 Renewable Portfolio Standard; and 4) as I mentioned earlier,
25 it is a key component of our Smart Grid goals. One of the

1 challenges and barriers that energy storage and I think it
2 was Dave Hawkins who mentioned earlier, that for the
3 gentleman from Southern California Edison, that the policy
4 is so important in thinking about the applications of
5 storage, but it's really the policy and what we focused on
6 is what determines how it will be deployed in the market.
7 And you know, as an advocacy group, it was a perennial
8 frustration of ours that storage is relevant in so many
9 areas, in just about every area, just pick one, but yet
10 there was no focus, it wasn't the top one, two, or three
11 priority from any one group, in any one of those silos. And
12 fortunately, we're very thankful to have Jerry Brown and
13 Nancy Skinner's leadership, we now have AB 2514, so we're
14 very excited about the leadership and the focus that that
15 will bring across the many different policy areas in
16 California.

17 So, I thought it was worthwhile to spend a little
18 bit of time talking about AB 2514. There has been some
19 misconceptions about it, but it passed, it was just signed
20 into law on September 29th, and this would establish
21 procurement targets for 2015 and 2020, and for the POUs,
22 2016 and 2021, respectively. And some key things that folks
23 are a little confused about, one, it is technology neutral,
24 so any of those technologies that I mentioned above, would
25 qualify towards meeting the goals in this bill, however, the

1 technologies have to be commercial and they have to be cost-
2 effective. Secondly, the bill is also ownership neutral, so
3 the assets could be rate-based, it could be procured from a
4 third-party, it could be customer owned and procured. And
5 any of those models work towards satisfying the procurement
6 requirement. And finally, electrical corporations with less
7 than 60,000 customers are exempt. So, that's all I have to
8 say about that.

9 There have been a lot of discussion today about the
10 many value streams that storage provides, and you know, one
11 of our challenges has been the policy and regulatory focus.
12 The other challenge has been how you align the many benefits
13 to the purchaser of the equipment, and it's our hypothesis
14 that, through that regulatory focus, we can remove the
15 market barriers, align the existing benefits with the
16 existing costs, and we will see cost-effective systems be
17 deployed and be deployed rather quickly. So that's why we
18 say government intervention is needed to align those
19 benefits with the cost.

20 Because today is about renewable integration, I
21 wanted to talk a bit about some of the applications for
22 storage for renewable integration, and I'll go quickly
23 because many of them have been addressed today. The first
24 is a cleaner, more effective alternative for frequency
25 regulation, 2) storing renewable over-generation, 3)

1 assisting with renewable generation smoothing, or shaping,
2 and the fourth is generation shifting, so literally taking
3 bulk generation, and I think the gentleman from Eagle Crest
4 addressed that very well, as well as ramping.

5 This is a chart that has been presented many times,
6 and it's based on some work that CAISO did in '07, to
7 estimate the increased need for regulation and also ramping
8 as we achieve different RPS standards, and I think Dave
9 already covered this a lot. The bottom line is we're going
10 to need more regulation. What's really cool, and this is
11 another view of some of the same data that Dave Hawkins
12 presented, is that storage, and in particular, fast storage,
13 is more capable of following a faster, frequently changing
14 regulation signal than traditional resources, and the
15 traditional source that's provided this service is fossil
16 generation. What you see on the left is the command from,
17 say, the System Operator, and this is the response from the
18 generator output, you can see it's kind of slow, it's not
19 really matching that signal. In the flywheel example, this
20 is real data, I believe it was, whereas this is in PJM
21 territory, what it shows is you cannot even see the
22 difference between the pink and the green line because they
23 are so closely matched. And the idea is, when you have a
24 resource that can meet your needs so accurately, a couple of
25 great things happen, a) you need to buy less of it, so that

1 is where some of the savings and some of the benefits come
2 from, and 2) this resource just tends to produce less
3 emissions, it is super efficient and there is no on-site
4 emissions. So a KEMA study from January of 2008 showed
5 that, looking at 20 megawatts of regulation over a 20-year
6 operating life, that storage actually dramatically lowers CO₂
7 emissions, as compared to some of the other sources.

8 Another way that storage can help with achieving our
9 renewable portfolio standard is, when you look in time, now,
10 this is not the case today, and I'd like to thank Eric
11 Cutter and the folks at E3 for this analysis, it was just
12 presented last Wednesday at the Permanent Load Shifting
13 Workshop, but through E3's work, they did some scenarios and
14 said, well, you know, in 2020 when we have a lot of wind on
15 the system, and they modeled in this case almost 9,000
16 megawatts, what is going to happen? And what you see here
17 is that the wind generation sort of exceeds the must run net
18 loads, so this is a synchronous wind power and this is the
19 over-generation. And the idea is that, if we had storage
20 installed at that time, we wouldn't need to curtail that
21 valuable clean renewable energy.

22 Another application of storage is what we call
23 smoothing and this is an actual output chart of a Vanadium
24 Redox flow battery in Japan. This system was installed many
25 years ago, it's Tomamae wind farm, I think it is in

1 Hokkaido, and what this shows is you have the blue line
2 here, this is the charge/discharge function of the battery
3 in response to the wind production, which is this green
4 line, and then what you see, the net line is this red line,
5 it is moving much smoother. And because Hokkaido is an
6 island of crude systems, really fragile, they much prefer to
7 see output that looks like the red line than the green line.

8 I would like to switch gears a little bit and talk
9 about how storage can be used system-wide, and this is just
10 a what if scenario, I think I represented this here a couple
11 years ago, and the idea is that we don't necessarily need --
12 large pumped hydro plants are great, we need those in our
13 system, but you can accomplish a lot even with very small
14 storage systems that can be cost-effectively deployed today.
15 This is a what if scenario that EPRI put together some years
16 ago, that shows a day in the life of CAISO. And this dotted
17 black line shows the typical summer daily demand, this blue
18 line shows what the demand would look like post- the CSI
19 implementation, so imagine if there are 3000 megawatts of
20 solar put in on the system, and this resulting red line is a
21 what if - what if we put in five kilowatt hours of storage
22 for each KW of solar - it was arbitrarily chose, but the net
23 result is quite dramatic, you see this peak is dramatically
24 clipped and you have more demand at night. Okay, while
25 we're on peak, I know that earlier, the gentleman from

1 Edison talked about the Chino project which was a 10
2 megawatt, four-hour lead acid system that was installed and
3 operated in Edison's service territory from 1988 to 1996,
4 quite successfully, and I often hear people say, "Well, we
5 closed it down because it met its research objectives and it
6 wasn't cost-effective." But then, when you ask people
7 involved in the project, "Well, how did you define cost-
8 effective, because we don't have a cost-effectiveness
9 methodology for storage today," the answer that I was told
10 was, "Well, we looked at the capital cost of the equipment
11 and we divided it by the difference between the peak and the
12 off-peak, and it was a really long time. And that's
13 certainly one way of looking at cost-effectiveness, but we
14 would like to offer another perspective, so a couple months
15 ago, we authored a White Paper looking at the cost-
16 effectiveness of storage, and decided to model lead acid in
17 that application since we had a successful demo, lead acid
18 is commercially mature, you can buy them today, and we said,
19 "Well, what if? What if we built that plant? And instead
20 of 10 megawatts, let's make it 15 megawatts. And what if we
21 built that, instead of building a 15 megawatt gas-fired
22 peaker?" And what this chart shows is that using very
23 conservative assumptions of what lead acid would be
24 installed for today and, again, this is not a sales
25 commercial for lead acid because we represent all

1 technologies, but it's just an example, if you use the same
2 methodology that the CEC uses for comparative cost of
3 generation, which looks at dollars per megawatt hour
4 discharged per year for a 20-year horizon, or dollars per KW
5 per year, so the same use cycle, side by side, centralized
6 plant, centralized storage plant, the storage was cheaper!
7 Now, I actually was a little surprised, I was expecting it
8 to be a little more expensive, but in this case, it was
9 downright cheaper. And the beauty about the storage is you
10 don't have to build a 50 megawatt battery, you can sprinkle
11 it around and put it where you need it the most. Okay, Mike
12 is looking at his watch, I'm going to hurry up.

13 These are all the assumptions, the case studies on
14 the website, including the spreadsheet model, I invite you
15 all to take a look at it. The other great thing about
16 storage is, there's no on-site emissions and what we did was
17 we assumed charging the battery with PG&E's energy mix,
18 delivered air quality savings of 55 percent in terms of CO₂,
19 85 percent in terms of NO_x, 96 percent in terms of NO_x and
20 SO_x, it was tremendous. So I encourage everyone to take a
21 look at that and think about the cost-effectiveness of
22 storage a little differently.

23 So, switching gears yet again, there is a lot
24 happening, one minute, I'm wrapping up. As I mentioned
25 earlier, storage is fundamental to many energy policy

1 initiatives here in California and thanks to all of you, we
2 are in some ways the leaders in thinking about grid storage,
3 nationally. We have the right foundational legislation, we
4 have this fabulous integrated IEPR planning process, we have
5 very active regulatory implementation at the PUC across a
6 number of areas, and we have a lot of activity at CAISO, and
7 what we need, and what I'm asking for at the CEC and all the
8 agencies involved in our energy policy framework here in
9 California, is we need a little more leadership, more
10 leadership to leverage storage's many strengths across all
11 these areas, more leadership and coordination. So, we like
12 to think about the system not only in terms of supply and
13 demand, transmission and distribution, but also in terms of
14 system optimization that can be accomplished with energy
15 storage.

16 Finally, we have some thoughts and ideas and we will
17 be filing comments, written comments, but there are some
18 specific ideas for how the CEC can accelerate progress, 1)
19 we have a wonderful Smart Grid vision for 2020, we need a
20 vision for storage that is focused on storage and its many
21 applications across the system, 2) keep up the good work
22 with PIER R&D Plan, 3) to support incentives to encourage
23 utility procurement of energy storage capacity and services,
24 4) encourage the CAISO to implement that tariff, especially
25 for regulation energy management, 5) the CEC's activity in

1 siting new power plants and new T&D can be a really key
2 gaiting factor to make sure that, as we do that, is there a
3 cheaper alternative, could that same function or goal be
4 accomplished another way with storage? And last but not
5 least, we have a recommendation to add storage to the
6 loading order and potentially consider starting energy
7 storage collaborative similar to how you've done wind and
8 other renewables. Thank you.

9 MR. GRAVELY: Thank you, Janice. So we still seem
10 to be having mic problems here. I think we'll work on that
11 over the lunch if you can from there. Any questions real
12 quick, one question from anybody for Janice? Okay, this is
13 the last presentation before lunch, and so we've heard from
14 both the PUC and SCE about the A123 system going in
15 Tehachapi at 32 megawatt hours, and we will hear the
16 specifics from Charlie.

17 MR. VARTANIAN: Thank you, Mike. And thank you for
18 the opportunity to speak and to join a really great panel,
19 providing both a range of backgrounds and perspectives. I
20 would like to say that A123 is a very satisfied member of
21 CESA, I think they gave a really good hit on some topics I
22 would have otherwise hit, so I'm going to stick to some of
23 the technology at hand at A123 specifically is bringing, but
24 I would also like to offer up that it generalizes to a
25 number of advance technologies, and I will say legacy

1 technologies discussed today that are expanding their
2 capabilities. So, part of my - to frame my discussion,
3 message 1, storage is not new to the energy system, but
4 within the last 10 years, there have been significant
5 technical and commercial breakthroughs, major incremental
6 progress that make the technology relevant to applications
7 where it would otherwise have not been considered even three
8 or four years ago, and we're a good example of that; 2) so I
9 would say, as an asset class, storage shares that across the
10 spectrum, we have a diversity of capabilities from very fast
11 to very long where advances have been made, and 3) another
12 shared attribute we have is - I'll put forward my opinion -
13 regulatory evolution is a number one need, that we are
14 technically credible and commercially credible today for a
15 range of what we can access as niche services. We can
16 definitely provide more benefit with a little bit of
17 regulatory evolution work similar to the technology.
18 California is at the forefront somewhat, maybe not at
19 California's prompting, but leaps, for example, in that FERC
20 case, Western Grid Developers is at least bringing storage
21 into the discussion of the cost recovery mechanism from that
22 wholesale angle. So, what are we doing? A123 Systems
23 builds lithium-ion batteries and battery-based systems using
24 - I want to point out one cathode chemistry - nanophosphate.
25 That one chemistry provides such incremental leaps in

1 capability that we're not worrying about other chemistries,
2 we're just packaging a single cathode from 25 kilowatt, 50
3 kilowatt systems, to an in construction 20 megawatt, 15
4 megawatt system, once again, it scales out farther, there is
5 no limitation on our architecture, the system level will go
6 to 200 megawatts, and it didn't get a lot of attention, but
7 we did have a highly rated proposal for a 100 megawatt
8 system in PJM as part of the DOE Stimulus funding.

9 So we do this in the U.S., using nanophosphate
10 chemistries, manufacture components in China and the U.S.,
11 but systems for the grid are built in Hopkin, Massachusetts.
12 So, we are one example within the storage community of
13 massive gains and capabilities. And this is driven - for
14 us, what is very convenient, it is one attribute, it is a
15 high contact area within the cathode, translates to low
16 impedance. What does that mean at a battery level? That
17 means that the battery has over 98 percent round trip DC
18 efficiency. You would not have a battery-based system doing
19 frequency regulation with a 95 percent capacity factor
20 continually exchanging energy, but for a battery that gave
21 you 98 percent of all the energy you put in back out. That
22 lower internal impedance also means very low heat, so the
23 degradation mechanics that otherwise destroy batteries,
24 they're still present, but they're extremely slowed down and
25 they're highly linear. So, once again, even on a highly

1 intensive utilization, like frequency regulation, the need
2 to refresh, add capacity, to maintain a system rating, we're
3 talking years, not months or days. Even at a full depth of
4 discharge, if you were to do it - use it for diurnal, let's
5 say, shift - energy shift - 10,000 round trip, full depth of
6 discharge, once again, these are quantum leaps at the
7 technology level that the market, the users, are starting to
8 access.

9 This will be posted, but once again, it comes down
10 to life durations that were unheard of before ours and other
11 advance electro-chemistries have come into play, very high
12 round trip efficiencies, combine that with the new
13 efficiencies and the robustness of megawatt scale inverters,
14 and here is a key element, and I love to see the ISO in the
15 audience, and the utilities, you have a four-quadrant
16 unified power flow controller that is going to be a very
17 important grid asset, forget about all the market crap,
18 it'll do its job there, it's commercial today in that
19 market, as a grid asset. And one of my goals is to bring
20 the ISO planners and the utility planners a WECC accepted
21 model that they can run and a dynamic simulation to show
22 it's bringing these abilities to bear for transmission
23 solutions. So there are some pictures. One of our methods,
24 once again, concentrate on a single chemistry spread across
25 a number of not just power applications, but market

1 segments, the same cells being built for automotive are the
2 ones we're using within the Grid. And I will state A123's
3 viewpoint, what we're doing with Edison and Detroit Edison
4 for demonstrations, the DOE demonstrations co-funded here in
5 California for Tehachapi, isn't a proof of the battery, we
6 have a million miles accumulated on that same exact battery
7 chemistry happening today, two years in service, hybrid
8 busses in San Francisco, the cells work, we have no lack of
9 confidence that that'll be proven out, that isn't what we're
10 hoping to prove, it's the applications, putting into its
11 system that does something useful for the Grid. This went
12 out in 2008 with a client, AES storage, that used it as a
13 test system. Could it receive an AGC signal and respond?
14 The shorter answer is yes. Could it follow it accurately?
15 Yes. Could it respond quickly? Within 20 milliseconds, its
16 stated ramp rate in its certification testing and tested
17 again, so it was 999 megawatts per minute, and that's
18 because those were the figures available within the form.
19 Once again, Pacific Northwest National Labs is really doing
20 topnotch work, and KEMA has and continues on quantifying -
21 what is the value of speed? And it translates into a lower
22 amount of capacity needed. I will just say this, we have a
23 client that has approaching 36 megawatts of capacity in
24 various markets, no tax incentives, no government
25 underwriting, with commercial payback, selling frequency

1 regulation and spending reserve with a battery-based system.
2 So, if you have any conceptions or, even based on the
3 research that is out and present today, what we're actually
4 doing in the real world in a number of markets might
5 surprise you in terms of what we're delivering commercially.
6 Feel free to ask me outside of this. There are some
7 notional pricing points I am comfortable sharing that are
8 out in the public.

9 So, we are going to extend our early experience and
10 I'd like to touch on Smart Grid. Smart Grid does one great
11 thing, it brings interoperability as a requirement, which
12 makes it easy for the receivers, utilities can understand.
13 All I am are power injection, power absorption, VAR
14 injection, VAR absorption, either responding to a
15 dispatcher, a schedule. A transmission planner or a
16 distribution engineer really isn't going to delve into my
17 chemistry, so I want to present a device that is
18 understandable to them in their context. The Smart Grid,
19 that the whole encompassing effort, really makes that
20 possible, gets us talking the same language with the Grid
21 people, please have spoken really well in terms of
22 characterizing the renewable integration challenge and
23 opportunity. We are really lucky to team with Southern
24 California Edison, who has a Grid asset at the right place,
25 with the right challenges, against which we will team to

1 show that advance batteries can bring a number of
2 capabilities of relevance, and what I want to point out is,
3 as the vendor, A123 didn't bring the list of functionalities
4 that we're going to demonstrate here, it came from the
5 utility and the CAISO. The quick list, didn't know if it
6 was going to be on the Edison slide or not: transmission
7 related benefits, voltage support, grid stability,
8 decreasing transmission loss, diminished congestion,
9 optimized their renewable transmission investment, system
10 level functionalities that we'll demonstrate, and this once
11 again, in collaboration with the ISO, the utility, and the
12 A123, provide system capacity, demonstrate renewable energy
13 smoothing, demonstrate renewable energy shifting, and
14 ISO/market applications, frequency regulations, spending
15 reserve, ramping, energy arbitrage, people have spoken to
16 the cost, I want to stick on that, go back to that, for a
17 moment. Once again, I want to talk about what we're doing
18 today that we can extend that for these applications.
19 Twenty megawatts is being built in New York by AES Storage,
20 average clearing price is north of thirty mills, our fully
21 amortizing our capital cost in the O&M over the megawatt
22 utilization is on the order of \$20 mills, so, today,
23 Charlie's opinion? Not cost-effective in the California ISO
24 for that single value. But I'd like to put out, if we
25 opened up and brought the black start value, the VAR value,

1 other values, we start getting there. But, once again, out
2 there commercially today, 20 megawatts under construction,
3 we will take that same technology and extend it to these 13
4 applications, and I think Edison was wise in terms of,
5 "We'll do it serially one at a time, but we'll also start
6 answering what you can do coincidentally." And that's going
7 to be a key aspect of the demonstration phase taking place
8 mid-2012 through mid-2014, is the test phase.

9 Detroit Edison has a different - very different in
10 terms of scope, 25 kilowatt community energy storage
11 systems, 20 of them co-funded by the DOE, here I think the
12 real value out of this is going to be the aggregation and
13 talking to a utility in context of a single unit, and a
14 fleet of units. So, ICE Energy, I think, is a real leader
15 among our peer group, and we hope to catch up a little bit
16 in our understanding of how do you actually accomplish this.
17 There can be big power through aggregation, the Demand
18 Response community, already is accessing and utilizing the
19 power. I think we need a few post docs in math at A123
20 before we get our arms around aggregation. But, in the mean
21 time, we'll learn with Detroit Edison, how do we at least
22 execute that capability. Those are once again utility
23 driven. They put the list of functionalities up and they
24 basically left it to us to respond, can we deliver that
25 capability or not, and I'll put it in these terms, we gave

1 them a commercial quotation against those requested
2 requirements. This is for California, in particular,
3 because these scenarios exist here. And once again,
4 slightly aimed at the ISO. I do intend to get ultimately
5 WECC approved for formal transmission study, path rating
6 studies, interconnection studies, a number of models, so
7 they can start being incorporated and used, and I'd really
8 love to hear that the Grid planning process is going to
9 consider how it's going to integrate storage. Well, one way
10 we could make it easier from the advocate side is bring them
11 a model. I have the term "innovation fatigue" and when I
12 talk to the planners, engineers, they've had enough, and the
13 only time I get engagement is if I can explain how it helps
14 them meet known problems, how do they deal with AB 32, SB
15 17, RPS accomplishment, and now, on top of that, AB 2514
16 compliance? They are really receptive when I talked about
17 not storage as a new thing to deal with, but a new tool to
18 meet what are basically approved challenges set before them.
19 One way I think as a community we're going to do that - EPRI
20 did this 20 years ago - I am using EPRI models today in an
21 interconnection study, but it's a one off approval, and we
22 can't do that effectively, we need storage models. And here
23 we go, Phaser measurement units, I want to commend WECC,
24 ISO, and Southern California Edison, who really was the
25 champion in this. Phaser measurement units connected with

1 every storage device is going to prevent future cascading
2 outages within our area. The last cascading outage in 1996
3 was an under damped real power oscillation between us and
4 the Pacific Northwest. Those same mechanics exist today,
5 provide that same threat. That's Chino down on the left-
6 hand corner responding to an inter-area frequency deviation,
7 and showing that the GE energy storage power system
8 stabilizer - you know, this was done 25 years ago, they had
9 a power system stabilizer designed and built for a bi-
10 directional energy storage device. Chino? They could do
11 frequency damping. Our battery is completely technically
12 capable of doing dynamic, inter-area frequency area damping,
13 and I would say one megawatt doing frequency damping is a
14 benefit, and it never hurts, you can get 100 megawatts doing
15 dynamic frequency damping, you do start bringing the system
16 back into compliance with what otherwise would have been an
17 outage. Now, that's Charlie speaking, not A123, but I know
18 that once we get the transmission planners, the models,
19 they'll start seeing this aspect of benefit and it will help
20 the T Investment Recovery argument. You know, storage, I
21 think, is amplification-based in terms of how it should be
22 monetized and the investment recovered, why box it "TDG" or
23 "S"? I would say it depends on how you're using it and who
24 is making the investment. Thank you.

25 MR. GRAVELY: Time for one or two questions. Any

1 questions for Charlie? Okay -

2 MR. VARTARIAN: Lacking a question, can I use that
3 one minute? To "asks" - get storage line item discretely in
4 the loading order, and get it discretely dealt with in the
5 IEPR as a stand-alone asset, not in context of efficiency or
6 demand response, or even cars - it fits great there, but as
7 a stand-alone element. Thank you.

8 MR. GRAVELY: Thank you, Charlie. So I thank all
9 the morning speakers. We have a full agenda ahead, so we'll
10 break now for lunch, and be back at 1:15. And hopefully
11 we'll get the mics working a little better. As you might
12 have learned, we heard they upgraded the system about a week
13 ago, and we seem to be the sacrificial lamb for the WebEx.
14 Thanks.

15 (Off the record at 12:17 p.m.)

16 (Back on the record at 1:20 p.m.)

17 MR. GRAVELY: So, for those of you back online
18 again, this is Mike Gravelly. We're starting the afternoon
19 session and we're pleased to have our first speaker here.
20 Robert Schainker is going to talk quite a bit about a couple
21 of PG&E projects that EPRI is actively involved with. You
22 heard from Chris this morning that the PUC had approved two
23 projects, one of them was the SCE one, the second one is the
24 compressed air project that PG&E is doing, and also, soon,
25 we're hear how soon from Robert, PG&E will have the largest

1 battery storage system in California operating sodium sulfur
2 system, so we're going to hear about both of those today and
3 I think PG&E is online, Eric and Kevin are online if there
4 are questions at the end. With that, I'll turn it over to
5 Robert Schainker.

6 MR. SCHAINKER: Great, thank you. Thank you very
7 much, Mike. And of course, I am here representing PG&E as
8 one of the members of their project team for both the
9 compressed air project and the sodium sulfur battery
10 project. Before getting into that, though, I wanted to
11 specifically call out the fact that Mike Gravely is to be
12 commended for getting all the right people in the right room
13 at the right time, in fact, at the same time. And this
14 effort to have this meeting took many months to prepare and
15 orchestrated a lot of people in the process, so I wanted to
16 personally thank Mike Gravely and his team of people for
17 making this happen. So, thank you again, Mike.

18 With this introduction, let me go to the first slide
19 here, and this sort of reminds everybody of that renewable
20 mix for PG&E, for various years on the horizontal axis from
21 2005 up to 2020, and what you see is a very large growth in
22 solar, which is the yellow, and a very large growth in wind,
23 which is the lowest colored sort of a bluish color, and
24 everything here is shown on a percentage basis by year. So,
25 this sort of sets the stage for why energy storage or any

1 other kind of rapidly ramping technology that can
2 accommodate the power fluctuations from both solar and wind,
3 it needs to be really demonstrated in a real world
4 environment, not a simulated environment, a real world
5 environment on a real utility, on a very good utility here
6 in California, PG&E. This slide here has actually been
7 shown a few times and there may be a few other slides in
8 this deck that have been shown by others, which I didn't
9 know until I came here, but this slide just reminds
10 everybody - the orange is solar, the wind is green, and when
11 you combine them together, ideally, they do levelize each
12 other out to some extent, but on the shoulder are these huge
13 ramping requirements that has already been talked about by
14 the CAISO and other speakers here.

15 This slide 3 actually was prepared by EPRI and it's
16 been used in many forums by others, which is fine, and shows
17 in a long scale, on the horizontal axis in power, and on the
18 time axis, the vertical axis, in time and duration, the
19 various types of energy storage technologies. And,
20 fortunately, some of the speakers have actually taken the
21 log scale off, and I think I have that - no, I don't have
22 that here - and when you see pumped hydro and compressed air
23 in the tens of hundreds of megawatts, and even thousand
24 megawatts scale, for long hours of storage, and you take
25 away the logarithmic depiction on this slide, you'll see

1 that, in fact, pumped hydro dominates the upper right-hand
2 corner, and compressed air comes in very close behind that,
3 and all these other technologies, in particular the
4 flywheels and SMES, and the batteries and such, they are
5 really very small contributors to the real bulk energy
6 storage needs that the State of California requires. So,
7 I'll talk a little bit about both compressed air storage and
8 the sodium sulfur battery projects for PG&E now.

9 As indicated by me and others, but maybe not shown
10 in this sort of simplified sort of mechanism chart that is
11 on page 4, we have a lot of power fluctuations coming out of
12 wind and solar, and if you had the proper storage
13 technologies, NaS standing for sodium sulfur, CAES standing
14 for Compressed Air Energy Storage, and we have the proper
15 Smart Grid inputs, and the proper control algorithms, we
16 should be able to levelize the net input to the grid in a
17 dispatchable format for storage technologies and wind
18 technologies taken together. Now, the resources needed to
19 provide the various types of ancillary services are shown in
20 this slide, number 5, and this is just really a few of the
21 many ancillary services, in particular regulation is in the
22 five-minute timeframe, and the load-following is in the
23 intra-hour and hour ahead forecast timeframe, and what I
24 would call arbitrage, or "buy low, sell high" kind of duty
25 cycles for storage, is really in the day ahead timeframe.

1 Before leaving the slide, I must say, the words "ancillary
2 services," I think, is a misnomer because the word
3 "ancillary" generally refers to things that are secondary or
4 tertiary, and what we're going to find, in fact, it's been
5 mentioned already, but I'm sure we will find it in the real
6 world, that these ancillary services that the California
7 grid needs are not secondary or tertiary; as more wind and
8 solar come on the grid, they become a primary service that
9 is required to keep the system at low cost, and to keep it
10 stable, so we have to understand, as engineers and workers
11 here in California, that the word "ancillary services"
12 probably needs to be understood in a macro sense, rather
13 than in a micro sense. It turns out, by the way, that in
14 Europe, they don't even use this term, they don't use the
15 term ancillary services at all. They use the term grid
16 services, that is their analogue to the words "ancillary,"
17 and they keep on asking me when I go over there, why do we
18 use this word "ancillary," and I said, "Well, somebody
19 started using it and we're sort of stuck with it because
20 it's in the laws now." In fact, I think the first laws that
21 used that word were at FERC, the FERC rules about three or
22 four or five years ago started off with that set of words,
23 so we're stuck with those words. Slide 6 really talks about
24 resource adequacy and some people refer to it as RA, but
25 Resource Adequacy, and there really is a mismatch between

1 the actual real load and what the thermal and existing --
2 generally speaking -- existing generated units can supply.
3 So, this just depicts the same kinds of things that some of
4 the other speakers mentioned earlier.

5 Okay, now getting into the sodium sulfur project,
6 what PG&E is going to be doing is that they've already
7 purchased the battery, it is a four megawatt battery, it has
8 an inverter that allows it to operate in all four quadrants,
9 and what that means is it can charge and discharge in both a
10 real and a reactive mapping of power that is needed by the
11 Grid. And for those that have worked in complex number
12 arithmetic where the square root of -1 is equal to "i" and
13 we do all this imaginary number kind of calculations, I just
14 want to ensure everybody that reactive power for charge and
15 discharge, that batteries can produce is not imaginary, it
16 is actually real, and it is just an arithmetic process used
17 to calculate the phase angle between the sinusoid voltage
18 waveform and the sinusoid current waveform, so this is, if
19 you properly rate inverters for batteries, you don't rate
20 them in megawatts, you rate them in MVA and that's really
21 the hypotenuse of the triangle where the real axis is
22 horizontal and the imaginary axis or the reactive axis is
23 vertical. And this plant will have seven hours of storage,
24 it is a sodium sulfur technology. The partners involved are
25 certainly the California Energy Commission is co-sponsoring

1 this project, EPRI is providing some assistance, NGK is the
2 manufacturer of the sodium sulfur batteries, that is a
3 company in Japan. They got most of their money from Tokyo
4 Electric Power Company years ago to help develop this
5 battery that actually was originally patented by Ford Motor
6 Company, the sodium sulfur technology is a Ford Motor
7 Company patent, but that patent has long since retired and
8 many many companies have spent a lot of money trying to make
9 sure the sodium sulfur technology works properly and the
10 Japanese really did the finishing touches on that. S&C
11 Electric is the turnkey contractor for the project, they are
12 also providing the inverter for that project. The site is
13 the Hitachi substation, it is a major industrial consumer of
14 electricity on the PG&E system in San Jose, California, and
15 I'll show you a picture of where this plant is going to be
16 put. So, we've got support from the California Energy
17 Commission, the California Public Utility Commission, as
18 well as the Department of Energy for this project. We
19 expect to have the battery operational in 2011, which is
20 next year, and so there is a lot more work yet to be done.
21 But the battery itself, as been purchased and is at PG&E
22 now, it is not at the Hitachi site just yet, and the
23 inverter is in the process of being built and all the other
24 pieces of equipment are in the process of being put together
25 by S&C. So, with the battery already available and here in

1 the United States, we should be able to meet this deadline
2 if all goes well. Page 8 indicates what it is going to look
3 like, this is a picture of a sodium sulfur battery in the
4 upper right-hand corner, and you'll see there are vertical
5 modules, and each module is actually 500 kilowatts with
6 seven hours of storage, and they slide out on shelves,
7 basically, and then there's a separate small module for the
8 ACDC AC inverter, and this picture indicates that this
9 battery will get signals from the CAISO if all goes well,
10 and we will actually operate it in frequency regulation
11 mode, operate it based on our inputs from PG&E's database on
12 wind power coming out of the Tehachapi Wind Farms.

13 The objective is to improve reliability, and
14 particularly the voltage support at that particular site,
15 load shape, smooth out the peaks and the valleys, and to
16 optimize the grid at this PG&E substation area for
17 renewables integration. We will look at Demand Response,
18 black start, ancillary service duty cycles for this battery.
19 This picture on the next slide shows a top level view - I
20 think it is a Google shot of what the Hitachi facility looks
21 like in the upper left-hand corner, and the actual big arrow
22 shows a blow-up in the lower right-hand corner of the small
23 section of the Hitachi facility, and in blue, on the far
24 right of the lower right-hand corner picture, shows the
25 power conditioning system, the AC/DC/AC inverter, the PCS as

1 we call it, and then there will be two megawatt modules for
2 this four megawatt facility. So, that's what it's going to
3 look like and there is space available to site this and PG&E
4 is going through all the necessary permitting and licensing
5 issues associated with this installation as we speak. BESS
6 stands for Battery Energy Storage System, and sodium sulfur
7 is NaS, some people call this the NaS battery because, on
8 the Periodic Chart, Sodium is a chemical that is represented
9 by Na, and Sulfur is represented by the letter "s." So
10 that's why it's called "NaS," if people hear that word, that
11 is what they're referring to.

12 Now, on the compressed air storage project, this is
13 a much larger project, it is a 300 megawatt 10-hour bulk
14 energy storage facility, it is going to be sited in Central
15 California on the southern part of the PG&E Grid near the
16 Southern California Edison interface, and the partners in
17 this project are the Department of Energy, which is
18 providing about \$25 million. As an awardee, PG&E is going
19 to get \$25 million from the ARRA funding pool, the American
20 Recovery and Reinvestment Act of 2009, we can thank Obama's
21 Administration for that money, and the California Energy
22 Commission is also supporting this project. I think it is
23 \$1 million, EPRI is supporting the project with some time
24 and money, and also some subcontracting work to PG&E to do
25 the monitoring and performance analysis of the project, and

1 we've got the California Public Utility Commission has
2 already approved PG&E's Phase I cost for this project to be
3 put into the rate base, and the project has got three
4 phases, and we hope to get the whole project completed by
5 the year 2017. The three phases of this project are shown
6 in the left corner of this slide, number 11, and basically
7 the first phase, which is starting to take off literally in
8 the next week or so, once the final contract is signed, will
9 be approximately two years, three years long, and is to do
10 all the permitting, the geological studies needed for the
11 porous rock media that is going to be used to store the air,
12 and the transmission interconnection permits, etc. What
13 you'll find is that Phase I will do everything necessary for
14 PG&E to get to the point of issuing construction contracts,
15 basically that is what defines Phase I, so we'll do a final
16 design of the surface machinery, to match the underground
17 geologic formation that is going to be used, which is still
18 being investigated. And then, Phase II of the project is
19 all about construction, and that's where the bulk of the
20 money is going to be spent, to construct this 300 megawatt
21 10-hour facility, and then Phase III is a monitoring
22 program, a monitoring and performance program, where PG&E
23 has agreed with DOE that we're going to publish all --
24 appropriately analyze the data and publish the summary
25 operational data of this facility. Page 12 is a map of

1 portions of California, you'll see San Bernardino located
2 here on this map, Kramer, the Tehachapi yellow area is where
3 the wind farms are, the midway line is depicted as a major
4 line coming off the midway substation of PG&E, and the plant
5 is going to be sited somewhere in this neighborhood. I
6 can't say anymore specifically right now because the rights
7 to getting all the property locked up is still in the
8 process of being determined; once all the geology studies
9 are done, so we're very quiet about exactly where the plant
10 will be sited. But this gives you a rough idea where it is,
11 and you'll see Los Angeles is in the center, lower portion
12 of this slide.

13 The operational performance of the compressed air
14 technology, people may not be that familiar with it, but it
15 is very interesting. It is a technology that, in fact, is
16 not a pure energy storage technology, it has - it uses
17 electricity for the compression process off the grid, and
18 then it uses the compressed air that has been stored at
19 night from the compression process, with some heat that is
20 obtained from burning natural gas at about 4,000 Btu's per
21 kilowatt hour, and together the electricity off-peak and the
22 heat on-peak will produce one kilowatt hour of output
23 energy. So, really, it's like a hybrid vehicle to some
24 extent, it's a combination of pure storage technology and a
25 generation technology all in one type of unit. For those

1 that need more information about this technology, I would be
2 happy to talk to you privately about how the whole
3 thermodynamic cycle works, but it happens to be the second
4 of such type of plant in the United States, the first one is
5 shown in the upper right-hand corner of this slide number
6 13, and that's a picture of the Alabama Electric Co-op Plant
7 that was built back in 1991, and the machinery is in this
8 dark building that you see in that picture, and in the
9 foreground of that little picture is a pipeline that
10 connects the plant to the cavern, the air storage system for
11 that site. Now, for the PG&E plant, we'll have multiple
12 wellheads that are used to move the air in and out of the
13 air storage facility, but it'll go into that plant. The
14 plant design for PG&E will be an advanced plant design,
15 utilizing the new turbo machinery since 1991, and a new
16 thermodynamic cycle more than likely for the plant will be
17 used. Of importance to this group is the lower bullet, the
18 third bullet on this slide. This plant has approximately a
19 plus or minus 40 percent ramp rate for 300 megawatts, so per
20 minute you can get 120 megawatts a minute once it is
21 synchronized, and it takes about seven minutes to get
22 synchronized. And if you want to keep it online,
23 synchronized with a little duct burner in the process, it
24 can be available for that kind of ramp rate instantaneously,
25 once it is kept online, and that's being analyzed as we

1 speak, as well. So this is an amazingly fast bulk energy
2 storage plant can provide tens of hours of storage,
3 depending upon how big a bubble underground we make, and it
4 has a very very fast ramp rate.

5 Okay, slide 14, it is a summary slide. I've just
6 chatted, then, about the sodium sulfur project, four
7 megawatts with seven hours of storage, and the compressed
8 air plant with 300 megawatts with 10 hours of storage. And
9 that's it. If there are any questions, I could entertain
10 them now.

11 MR. GRAVELY: Any questions for Robert?

12 MR. SCHAINKER: Looks like Dave Hawkins is coming up
13 to the microphone and he'll ask a good question, I'm sure.

14 MR. HAWKINS: On the compressed air energy storage,
15 are you looking at a thermal storage capability to capture
16 some of the heat out of the compression cycle?

17 MR. SCHAINKER: Very very good question. It turns
18 out that this plant, as currently designed, will not be
19 utilizing any of the waste heat in its generation cycle,
20 however, this plant as currently proposed will provide an
21 experimental base to capture some of the heat and
22 compression and use it in a thermal storage facility on-site
23 at full scale and a good scale, and so I am particularly
24 interested in using this plant as a stepping stone, how many
25 years it will take, I'm not so sure, to do the necessary

1 homework needed in the field for thermal energy storage in
2 such a way that a compressed air plant won't even use any
3 fuel at all in the future. But to answer your question, no,
4 this plant is not using the thermal storage coming off the
5 compressed cycle, but it has the facility that we can
6 capture and use that thermal energy to do some experiments.
7 But, good question. Thank you, David. Any other questions?

8 MR. GRAVELY: Thank you, Robert.

9 MR. SCHAINKER: Good. Back to you.

10 MR. GRAVELY: Thank you very much, Robert. And,
11 again, we're looking to California to have so many of these
12 very good storage projects built and we'll get a chance to
13 see some real progress over the years here. So, the next
14 presenter we're having is from Pacific Northwest National
15 Lab, Jeff Dagle is going to be speaking from WebEx, so maybe
16 for one time, everybody on WebEx can hear him. Are you
17 online? Can you hear me, Jeff?

18 MR. DAGLE: Yes, I can.

19 MR. GRAVELY: Okay, I'm going to have Patrick flip
20 your slides for you, and you feel free to just let him know
21 when you want to change, and speak, you've got 15 minutes,
22 so thank you very much.

23 MR. DAGLE: Okay, thank you. Can we go to the next
24 slide, please? So, I'm going to be providing two examples
25 to talk about my topic area, the first example is a wet area

1 energy storage concept, and this was a project that was done
2 a couple of years ago, first with support from Bonneville
3 Power Administration, and then the Phase II was a joint
4 project between CEC and BPA, and the focus of the project
5 was to study the combining energy storage with a shared
6 frequency regulation service to provide AGC support to the
7 Western Interconnection. One of the things that we're
8 seeing with the increased penetration of wind energy
9 resources is that the regulation services, the frequency of
10 regulation services requirements are going up, and today
11 that is being handled by our central generation plants, but
12 we're seeing increased maintenance costs and wear and tear
13 associated with those Governors needing to continue to
14 respond to those signals. So I agree very much with the
15 comments from the other talk, when Dr. Schainker talked
16 about the requirements for a frequency regulation
17 increasing, that is going to be, you know, we see that going
18 very much in that direction in the future. So, there's a
19 couple things at play here, one of the things that we're
20 looking at with this project is sharing that regulation
21 service between multiple bouncing authorities. If you
22 notice on the diagram there, we've highlighted the
23 California/Oregon Interchange, those particular transmission
24 lines associated with that interchange, if they are at a
25 constraint, then you're limited in terms of how you can

1 share that regulation service, but most of those lines are
2 not at their constraint and you can share that regulation
3 service between multiple balancing authorities without
4 having impact on the reliability of the bulk systems. So
5 that is one aspect that's going on. The other aspect that
6 is going on is taking the fast regulation and allowing the
7 flywheel to implement that, and then backing that up with
8 the hydro for the slower regulation service. So, if we can
9 go to the next slide, through our modeled results here, what
10 we've seen is that the overall concept can reduce the
11 overall on a regulation reserve by 30 percent, and then, by
12 allowing the flywheel to take the fast regulation, you
13 minimize the wear and tear of your conventional regulating
14 units, in this case we focused on the hydro in the
15 Northwest. And then you let the various technologies sit
16 with what they are good at, so the flywheel can do the fast
17 regulation, and then the hydro-electric can support the
18 flywheel through its slower regulation, but the key
19 attribute there of working together is that you reduce the
20 overall energy storage capacity needed by the flywheel, so
21 you can keep the flywheel at a reasonable state of charge
22 throughout its charging and discharging cycles, by re-
23 dispatching the other frequency regulation services.

24 So, we focused in on BPA and CAISO as our test case
25 and we looked at the existing signals from the AGC on

1 generation control from those, and even though we focused on
2 BPA and CAISO for our test study, we don't see any reason
3 why this couldn't be used by the balancing authorities.
4 Next slide, please. So, the current phase of the activity
5 that we just wrapped up with the support from the California
6 Energy Commission included a field test of a flywheel
7 working in tandem with the signals coming from CAISO and
8 BPA, and what we did is we had a 25 kilowatt hour, 100
9 kilowatt flywheel, that was responding to the signals so we
10 can test and measure the ramp changes and that sort of thing
11 with that field test. Go to the next slide, please.

12 So, the way that the test was set up is we had a
13 regulation signal that then went to the control algorithm,
14 and that was split between the flywheel and the hydro, and
15 then the flywheel controller provided by Beacon Power was
16 actually being dispatched based on that flywheel regulation
17 signal, and then we can look at the combined results of
18 that. Go to the next slide.

19 So, these are some test results and the top graph
20 shows a combination of the hydro and the flywheel, to meet
21 the overall regulation service, and then the bottom chart is
22 showing the state of charge for the flywheel through a five-
23 hour period, and so the hydro is basically being used to
24 maintain that state of charge at a reasonable level. You
25 might have noticed that the flywheel that was under test was

1 a 25 kilowatt hour unit, what we were looking at was
2 simulating a larger capacity group of flywheels, and so we
3 were doing a field test with one of a simulated bank of
4 multiple flywheels in this case, so the overall capability
5 of the group was greater than the 25 kilowatts. If we go to
6 the next slide, so the good news is that this concept seems
7 to work pretty well, the hydro and the flywheel each respond
8 in ways that are appropriate for the technology. We also
9 see that combining the hydro with the flywheel reduces the
10 cost of the scheme because you don't need as much energy
11 storage in the flywheel if you can back it up with the
12 hydro. But, unfortunately, the bad news of the study is
13 that, at the current price of frequency regulation that we
14 see in the Western Interconnection, in the CAISO it is about
15 \$12.00 a megawatt and BPA is even less, about \$9.00 a
16 megawatt for regulation, the actual cost for providing that
17 regulation service doesn't quite meet our break-even price
18 for the scheme, so it is still a little bit too expensive to
19 implement today with the current cost regulations. So we'd
20 have to see the cost of regulation services go above \$12.00
21 a megawatt for this concept to make sense. And then if it's
22 just the flywheel, that the hydro backing it up would be
23 about \$20.00 a megawatt.

24 So, with this study, and, again, it was a combined
25 support by Bonneville and California Energy Commission, the

1 flywheel response is relatively quick and it allows the
2 hydro to provide the slow regulation, and while it looks
3 like an effective technology, and the ramp rates are
4 sufficient for doing what we want to do, it is still not
5 quite cost-effective to provide this regulation based on
6 today's price regulations. So, what we'd have to do is see
7 the regulation price increase to have this technology be
8 cost-effective.

9 So, what I'd like to do next is to move to my second
10 case study, so if we go to the next slide, and I apologize,
11 on my screen here, I'm seeing the title slide - or the title
12 of my slide kind of wrapping out the edge there, but example
13 2 is the Dynamic Load Control Scheme to Stabilize the
14 Transmission Network, and this is a project that we did a
15 number of years ago, looking at basically the concept was
16 could we have fast acting dynamic load control stabilize the
17 electric power grid? It leverages a project that we did for
18 EPRI in the mid-'90s, looking at the application of
19 superconducting magnetic energy storage, that would be
20 applied to the grid to stabilize the grid and provide
21 transient support. And that study had participation from
22 Bonneville, PG&E, Southern California Edison, Los Angeles
23 Water and Power, and San Diego Gas & Electric, and looked at
24 various locational aspects and control algorithms to provide
25 the right kind of energy, both real and reactive power

1 modulation, to stabilize the grid under a variety of
2 scenarios. This study that I'm going to be briefing here on
3 in a minute is extending beyond that study, looking at doing
4 a similar type of thing, but instead of installing a storage
5 device, could you get that same type of response through
6 fast acting load controls through interruptible loads. So,
7 basically a dynamic load control that would be attuned to
8 provide this kind of stabilization.

9 So, the objective that we had for this case was
10 increasing the imports in Southern California, and there is
11 currently some stability constraint paths in there that are
12 defined by the Southern California Port Transport Nomogram.
13 And so, this particular case, you know, this was a number of
14 years ago, so I was looking at the 1999 heavy summer case
15 when this study was conducted. The control action, then,
16 was we optimized to have the least amount of control action
17 to provide an increase in the imports of power through that
18 stability constrained path. And I looked at different
19 assumptions for what the control points would be, what the
20 feedback modulation would be, and then tradeoffs between
21 real and reactive modulation. If we could go to the next
22 slide, please?

23 So, to give you an idea of what this looks like,
24 across that stability constrained path, the blue plot would
25 be the response to the system at the stability limit, across

1 that path for the critical contingency, and then the red
2 plot represents what the same response would be if you
3 increased it 50 megawatts beyond the limitation of the
4 system, and so this is the approach that's used to identify
5 what the critical limit is. If you go to the next slide,
6 then what I do is increase the imports 400 megawatts beyond
7 that, and then the red line there shows that is what the
8 response would be without control, and then the difference
9 between the purple line and the blue line is finding the
10 minimum control, modulation control, that is needed to re-
11 stabilize the system back to that critically damp case.
12 Again, all of these results were conducted using the EPRI
13 extended midterm transient stability program, which is
14 equivalent software to the PSLF dynamics simulator, or the
15 PSSE transient dynamic simulator.

16 So, on the next slide, the top is the modulation
17 block diagram, modulation control block diagram, and that
18 provides the compensated control for the modulation. The
19 input signal was a variable that could explore different
20 options, including local voltage, local frequency, or a
21 global signal that would be sent out to all the controllers.
22 What I concluded in the study is that frequency was a good
23 input signal, and there was no real variation between global
24 measured frequency vs. a local measure of frequency. That
25 is the good news, that you can implement the scheme without

1 any high-speed communication requirements, you can have an
2 individual controller's modulating load using locally
3 measured frequency as the input to the control block diagram
4 there. So, you can take locally measured frequency, run
5 that through, and then determine the right kind of gains and
6 design constants, to get the properly formatted feedback
7 control. And so, if you look at the bottom chart, that's a
8 example where you would have 450 megawatts modulation and,
9 given the constraint of that modulation, you know, it shows
10 how that would respond to the cases that we're looking at in
11 the previous slides.

12 So, the next slide shows some results. In order to
13 provide that 400 megawatt increase in the transmission
14 enhancement, if I do that at a single location, then I need
15 450 megawatts, plus or minus 450 megawatts worth of real
16 power modulation, or plus or minus 500 MVAR of reactive
17 power modulation. Those are the different options that are
18 available. But one of the challenges with modulating load
19 is, if you are curtailing interruptible load, you may not be
20 able to do a full plus/minus megawatt of modulation like you
21 would with a storage device, for example.

22 The next slide shows a series of case studies to
23 explore whether you have a symmetric modulation vs. an
24 asymmetric modulation, and so how you interpret this plot
25 here is that, in order to get that 400 megawatts of

1 modulation, you need 450 megawatts for the plus or minus,
2 that is the blue square that is on that diagonal line, but
3 you can also achieve that if you go to the far left with 600
4 megawatts worth of just curtailing loads, so it is providing
5 a 600 megawatt injection and zero megawatts on the negative
6 side, and so if you just have control over 600 megawatts of
7 total controllable load, you can achieve that same result as
8 the plus or minus 450. So, already you're starting to see a
9 significant enhancement because plus or minus 450 is, you
10 know, a total of 900 megawatts worth of modulation, total,
11 is equivalent to zero to 600, so you start to see some gains
12 if you just looked at doing a zero to a plus number.

13 And on the next slide, there is some additional
14 advantage that you get by distributing that, so I took that
15 one case study, or that one example, where it is zero to 600
16 megawatts, and that is at one key location, you can install
17 at that location and modulate that level, and provide that
18 stabilization, is equivalent to if you take 10 locations in
19 the Southern California area, and you modulate those, the
20 same result occurs when you have 44 megawatts each, so that
21 is a total of 440 megawatts. So, there is some additional
22 gain that you get when you take that modulation and you
23 disperse it amongst the distributed load, as opposed to just
24 doing it in one location. I repeated that study with the
25 100 sites vs. the 10 sites, and I got an equivalent number,

1 roughly 440 megawatts. So there is kind of an asymptote
2 that reaches there between one and 10.

3 And I already mentioned that local voltage and
4 frequency had similar results, but one of the things that
5 you need to watch out for with voltage is these particular
6 transient models don't model the distribution system, they
7 are basically aggregating all of the load at the substation,
8 and then I'm applying my modulation controller, or my power
9 injection at the substation. If you went to actually
10 implement this in real life, there might be some issues with
11 voltage, you know, depending on how that particular feeder
12 is regulated and what the voltage regulation schemes might
13 look like. However, frequency is still a valid signal
14 because there is no difference between frequency at the wall
15 plug vs. frequency at the substation. But then, the
16 lingering issue is how to actually implement this.

17 So, on the next slide, what's happened since then is
18 that the Department of Energy has provided support to
19 research what we call the "grid friendly appliance
20 technology," and it incorporates some of these concepts of
21 frequency response of load, and this has been implemented in
22 the Pacific Northwest Grid-wise test bed demonstration, and
23 so we have some results of actually implementing frequency
24 response of load at the demonstration scale where we have
25 hundreds of appliances that are responding to grid

1 frequency. And there is a larger Pacific Northwest Smart
2 Grid demonstration project that is being funded through the
3 ARRA grant on working with multiple utilities to implement
4 more of these Demand Response technologies, and so that will
5 be more results from that experiment coming up here in the
6 near future. So, that is what I had prepared and hopefully
7 I'm within the timeframe that you had allocated for me.

8 MR. GRAVELY: Very good. Any questions in here in
9 the audience for Jeff? All right, well, thank you very
10 much, Jeff.

11 MR. DAGLE: Okay, you're welcome.

12 MR. GRAVELY: We'll move on to the next speaker.
13 And, actually, I was going to say here, for those who don't
14 know it, Jim Parks is going to be teaching a class in
15 proposal preparation after this is over. SMUD won a third,
16 if not a half of the Smart Grid proposals in California. I
17 think they have received the largest number and the largest
18 amount of money. And fortunately, also for transition, part
19 of the work they're going to be doing is using energy
20 storage and automated Demand Response, so that will
21 transition us from here into the Auto-DR, which is the last
22 presentation for the day, so, with that, I'll turn it over
23 to Jim.

24 MR. PARKS: Thank you, Mike. Yeah, we did on the
25 SGIG grant, I think we got 65 percent of the grant money

1 that came to California. On the one hand, we were a little
2 embarrassed, but on the other hand, we were quite elated. I
3 want to talk a little bit about our storage projects here,
4 so, you know, what's driving our interest. We have
5 greenhouse gas regulations and we have renewable portfolio
6 standards right now in California, it is 33 percent
7 renewables by 2020. With the way the Legislature works, we
8 wouldn't be surprised to see them say, "Hey, 50 percent
9 renewables by some date down the road," and these renewables
10 tend to be intermittent resources that are, you know, a
11 little difficult for us to manage from a grid perspective.
12 And these are things that I think you and the audience all
13 know that. We also have a summer peak load where we need
14 400 megawatts for just 40 hours out of the year, and that's
15 actually a significant issue for us, so we see things like
16 energy storage and Demand Response as ways to overcome some
17 of those issues that we have.

18 SMUD also has a goal that the Board established to
19 reduce our greenhouse gas emissions by 90 percent by 2050.
20 Now, if you're in the electric utility industry, you'll
21 realize that that is a significant number if you have any
22 fossil fuel generation at all, and we do, we have some
23 natural gas plants, some co-generation plants, and so, for
24 us to reach that goal, it creates what we call the energy
25 gap, and I'll show a chart on that - I mean, not today, but

1 I show a chart on it and it shows this wedge that is the
2 energy gap, and people ask me, "Well, where are you going to
3 get that? How are you going to fill that gap?" I don't
4 know, but it's a big problem for us, so we see some of these
5 opportunities that come from this. Solar has got a growing
6 role for SMUD. If you look there at the chart, you'll see
7 that in 2010, we have about 30-35 megawatts, and because of
8 a feed-in tariff that we recently issued, and it was totally
9 sold out the first day, we're looking at going up to like
10 170 megawatts of solar in the next three years, that's a
11 huge growth. Now, for us, people think, "Oh, solar is great
12 because it runs right across your peak." It's like, well,
13 not really. Our peak is 6:00 p.m. on a super hot day and
14 solar has ramped down significantly at that point in the
15 day. And so it doesn't really help us from a peaking
16 perspective. It does provide renewable generation, and
17 that's great, but from a peaking perspective, it's a little
18 bit lacking.

19 Wind, we have 105 megawatts of wind right now, or
20 102, sorry, we're going to install another 128 megawatts
21 next year, so we'll be up to 230 megawatts of wind. If you
22 look at the bottom chart there, you'll see the blue line
23 shows the profile of the wind, and the red line shows our
24 own load profile, and in general, what you can kind of see
25 with that is that we're peaking when the wind is kind of

1 ramping down, so here once again, we have another resource
2 where we're going, "Okay, how is this going to fit into our
3 grid? It's not really helping us in a peak situation." So
4 we do have some opportunities here.

5 And here is our approach to energy storage. We're
6 looking at both bulk storage and distributed storage. We're
7 doing several projects with the Department of Energy and
8 we're partnering with the CEC on many of those projects. We
9 want to know how much we're going to put in, how much is it
10 going to cost, what's it going to do, what are the benefits
11 it's going to provide to the District, and so we're using a
12 multi-pronged approach, so that we can develop an
13 understanding of the technologies and determine the benefits
14 to SMUD, and also you hear about things like cost-
15 effectiveness, I mean, the latest numbers I've seen on, say,
16 battery storage, for example, it's averaging something like
17 \$4.25 a watt, well, you know, we most recently built a
18 combined cycle natural gas power plant and it was less than
19 a dollar a watt, and so you start comparing this resource
20 that we have, you know, 24 hours a day, seven days a week,
21 vs. something that you have intermittently that may last 10
22 years if you're lucky. You start balancing those things and
23 you go, wow, there is a cost for this type of control that
24 we need in our system.

25 We're conducting several studies, and I'll go into

1 some of those. I mean, it sounds like I'm speaking against
2 storage, there is a place for storage. Right now, I see it
3 as a niche place. If prices come down, or prices of energy
4 go up, you're going to see that niche get larger over time.
5 One of the things we're looking at, the biggest project from
6 a storage perspective, is our 400 megawatt Iowa Hill Pumped
7 Hydro Project, and you can see here, we're looking to put in
8 this lake at the top of a hill, and this would provide us a
9 variable flow, variable speed, hydro system that will
10 generate - I've been told by the Manager of Energy Supply -
11 that it will be over 400 megawatts, ultimately. Now, this
12 isn't exactly an inexpensive technology, it can run up in
13 the \$2 to \$2.25 per watt range, but it's still much cheaper
14 than batteries and provides you with a lot more control. We
15 see this as an opportunity to really control, you know, the
16 wind resources, and to store the energy that we're getting
17 from these intermittent resources, and then are able to
18 control the flows to optimize our own system. This is the
19 artist's rendition of what it will look like. Now, this
20 project right now is in our Integrated Resource Plan and the
21 Board is considering it, and I'm not going to tell you that
22 we're absolutely building this project, but it's in a
23 licensing process, our Board is considering it, it is a
24 significant expense for a utility of our size, but when you
25 look at our goals going out with the 90 percent reduction in

1 greenhouse gases, the increased implementation of
2 intermittent resources, this could be a very big project for
3 SMUD.

4 Another thing we're looking at, at a subdivision
5 called Anatolia, there's something like 280 homes with 2KW
6 PVs so it's really dense PV, we're going to do three
7 different projects at this location, one, we're going to go
8 into homes and install storage systems in 15 homes, then
9 we're going to go out and we're going to install larger
10 storage systems at distribution substations, and then we're
11 going to install a larger system at the regular system
12 substation, and we're going to look at the impacts there and
13 see if there are some ways to optimize the solar. So, in
14 other words, as the solar is ramping down, the batteries can
15 pick up that load. We see this as a really good project for
16 us, and we're linked to the Energy Commission on that, and
17 it is in an ARRA grant, also. This just shows how the
18 communication is going to happen between the system and the
19 inverters, and on the photovoltaic system.

20 The next project we're doing is two 500 KW range
21 flow batteries, and one of them, we're going to put out at
22 Anatolia, and that's one we're going to put out at the
23 substation, the other one we're going to put on SMUD
24 facilities, we have a micro-grid project going out there
25 where we're going to have 300 KW, three 100 KW turbines,

1 natural gas turbines, 10 KW of PV, and we're going to put
2 the 500 KW batteries out there with six hours of capacity.
3 And so, we're actually testing a switch on that one where
4 these generators will be running and we're going to turn off
5 the power to our central plant into an office facility we
6 have out there, and then see if it's able to kick in time
7 and the micro-grid, run the project off grid, as it were.
8 We're sure hoping it's going to work because we like our
9 central plant and we like the office, and the people in
10 there like to have lights and air-conditioning and so forth.
11 And absolutely, we expect it to work.

12 But we're working with the Energy Commission right
13 now on two storage projects. This first one, I'm pretty
14 excited about, plug-in electric vehicle grid impact study.
15 You know, if you go out in Smart Grid sessions enough,
16 you'll hear people say, "Oh, electric vehicles are going to
17 have a massive impact on the system, and we're going to have
18 them plugging in to transformers, and so forth, and it might
19 blow them up, and we're going to have all these problems."
20 Well, hey, that might be the case, so let's try it out,
21 let's get ourselves a nice battery pack where we can
22 simulate 1, 2, 3, 4, 5 electric vehicles, let's set up some
23 25 KVA, 50 KVA, 75 KVA transformers, and let's simulate
24 loads on those transformers similar to what we see from, you
25 know, a number of homes, and then add a couple of electric

1 vehicles on there. Now, I'm kind of wandering, I used to
2 talk to our General Manager and say, "Hey ,I want to blow up
3 a couple of our transformers," and he would kind of look at
4 me like, you know, "I don't think so. We know you're in
5 R&D, you're not going to blow up our transformers," but we
6 have a great facility called Hedge where we train our
7 linemen and we can actually set these transformers up and
8 put these simulations on there, and actually real time, real
9 temperature, test these. And I want to see, you know, does
10 it blow a fuse? Does it blow the transformer? Does it do
11 nothing? You know, because we need to be prepared. The
12 electric vehicles are coming next month, they're coming, and
13 what's going to happen? These things are going to condense
14 in certain areas, it's not going to be spread evenly across
15 a utility, so you need to know, if you put one or two on a
16 distribution transformer, what impact it is going to have,
17 and we intend to find out. It will be a two-year project,
18 and then I'm going to use the battery pack for what they
19 call V to G, so Vehicle to Grid simulations where we're
20 actually going to take a look at taking the battery pack and
21 putting energy into the grid during peak periods, and so
22 that's another project, so this battery pack will have like,
23 you know, a four-year life before we start loaning it out to
24 other people.

25 And then, battery PV optimization, the picture there

1 shows what used to be a hydrogen fueling station, there is
2 80 KW of PV there, we took out all the hydrogen and we're
3 going to install something like 20 level 2 electric vehicle
4 chargers, which are like 240 volt, and one level 3 charger,
5 which is a DC charger, in the 400 plus volt range, and we're
6 going to install about 150 KW flow battery there to see how
7 we can optimize grid operations with electric vehicle
8 charging, integration of renewable resources, and the
9 battery. So, these are all great projects, and I was told I
10 was supposed to talk about open ADR, which I guess, you
11 know, I see Auto-DR and open ADR, the document I read
12 recently said that open ADR is the new name, and I'll let
13 Mary Ann correct that or not, and that Auto-DR is the old
14 name, so I thought, okay, I'll put "open ADR" on here. We
15 got \$1.5 million in ARRA specifically towards Auto-DR, Open
16 ADR, and our approach is to implement it first with our
17 partners in the ARRA grant, which is Los Rios Community
18 College District, they have four campuses in our service
19 territory, California State University, Sacramento, which
20 has one campus in our service territory, and Department of
21 General Services. So, once it is incorporated there, we'll
22 see what the impacts are and how it works, and then our hope
23 is to roll it out into a regular customer program after
24 that.

25 So, summary, I think it is going to play a

1 significant role in the future. We're doing a lot of
2 interesting projects around it, and I'm going to be
3 interested to see the results from those projects. I think
4 storage will be a viable option for us, like I said before,
5 right now it's more of a niche application, but I see that
6 growing, except for the pumped hydro stations. So, thanks.

7 MR. GRAVELY: Thank you. Any questions? He's got
8 his hands and everything?

9 MR. PARKS: Yeah, we're messed up! Okay.

10 MR. GRAVELY: Everybody is waiting for that class on
11 proposals here. Okay, so we're going to shift now for the
12 last three presentations and talk about Automated Demand
13 Response and Open ADR. So, Mary Ann Peitte is our Director
14 of Demand Response Research Center, it's been at Lawrence
15 Berkeley National Lab for quite a while, I'll let her tell
16 you how long and, in addition to what she normally does, I
17 challenged her to come up with Auto-DR as a Grid resource,
18 and we'll hear today how that's working.

19 MS. PEITTE: Thanks, Mike. So, I'm Mary Ann Peitte
20 from Lawrence Berkeley National Lab, and let me first answer
21 the question about Auto-DR and Open ADR, the word "Open ADR"
22 doesn't actually show up in the Powerpoint anywhere, which
23 is not normally how I do my Auto-DR talks, but I will
24 explain its use, it's very simple. Open ADR is the
25 specification for the communications, so the reason we

1 started calling it Open ADR was to distinguish it from
2 proprietary Auto-DR, there is a lot of proprietary systems
3 that aren't open. Open means it's an open API, so the
4 application programming interface is in the public domain,
5 and you could build an Auto-DR system using the Open ADR
6 specification. The reason we developed it was to allow low
7 cost automation. So, an open API allows innovation for
8 interoperability, and we're very active in the NIST Smart
9 Grid Standards. We hope to actually be issuing Open ADR 2.0
10 in the spring, that will be an SDO approved - national FERC
11 approved, open ADR spec, so I want to thank Mike Gravely for
12 his many years of support for Auto-DR and Open ADR, there's
13 a lot of folks in the audience today who have contributed to
14 this presentation, Nance Manson and Dave Watson from LBNL,
15 Betty Seta from KEMA, Dave Hawkins and Walt Johnson have
16 been involved. And today I'm going to walk through some
17 material that is related to the fast Demand Response and the
18 Grid integration.

19 I'm going to go through seven sections in my talk,
20 and this is a Scoping study, so it's not a formal report
21 yet, but we hope to finish it up before Christmas, but I'm
22 going to talk about why we're doing it, how Automated Demand
23 Response relates to traditional ancillary services, a little
24 about the experiences with Automated DR, and the activities
25 in the State of California. The methodology that I'm going

1 to review with you is related to actually coming up with the
2 bottom up estimate of the Automated DR potential for these
3 kinds of resources, so I'll go through a little about the
4 exercises we've been through and how this links to the CAISO
5 program, so what the ISO is looking for, and the preliminary
6 resource estimate, and where we're going with this work.

7 You've heard today about the Renewable Portfolio
8 Standards, we've gone through that many times today, and
9 that the wind and the solar resources are intermittent, and
10 there's a need for improving our ability to manage the Grid,
11 four gigawatts of ancillary services, four gigawatts of
12 battery storage was discussed in the KEMA report, Automated
13 Demand Response has been shown to supply ancillary services,
14 and I'll talk a little bit about that. So this concept
15 again is coming up with a preliminary estimate on what is
16 the size of the resource, and what kind of research is
17 needed to support growing the availability of Automated
18 Demand Response to facilitate more renewables on the Grid.
19 The picture there is the automated critical peak pricing
20 data from - I believe that is a 2008 or 2009 event, so
21 essentially what we've been doing in California is
22 automating Demand Response, all three of the electric
23 utilities, the IOUs have an automation server, Open ADR is a
24 client server technology, so the building is continuously
25 listening to signals from the automation server. I'm not

1 going into a lot of detail about Auto-DR infrastructure in
2 this talk, but more talking about the resource capabilities.

3 The things that are discussed in this slide, the
4 first two bullets are related to the fact that ancillary
5 services are traditionally with fossil fuels at a high cost.
6 We've talked about a variety of costs about batteries today,
7 and essentially the idea is that the Demand Response can
8 provide some of that response. How much is one of the
9 questions, what's the price point is one of the questions,
10 we've been able to install Automated Demand Response with
11 the utilities in California at a couple hundred bucks a
12 kilowatt, and that includes recruiting the sites and
13 configuring the systems. One of the things about Demand
14 Response is that we do not retrofit the controls, generally.
15 Generally, we're putting in automation and using the
16 controls that are existing in the buildings. So, in the
17 scenarios that I present, I talk about the existing controls
18 and what future controls may be able to support. Automated
19 Demand Response can also lower the carbon footprint because
20 we know that there is a synergism between energy efficiency
21 and Demand Response, and it's very often we see that, when
22 people try things for Demand Response, they actually migrate
23 to energy efficiency. So, the infrastructure that we're
24 deploying to deploy Demand Response can actually also
25 facilitate energy efficiency. How much that is done is

1 somewhat anecdotal, and it is something to keep an eye on as
2 we move forward. But the more we integrate energy
3 efficiency and Demand Response on different time scales, the
4 lower the cost will be for California to achieve its goals.

5 This slide shows you a little bit about our past
6 capability and what we've been doing. We have over about
7 100 megawatts in California of Auto-DR. And we call the
8 programs Auto-DR Programs, so if you go to San Diego or
9 Edison or PG&E, they're called Auto-DR Programs. Open ADR
10 is what is used to facilitate the Auto-DR. The programs
11 have tended to emphasize retail price response, so critical
12 peak pricing, peak choice, demand bidding, some capacity
13 bidding. We've done very fast Demand Response, so we took
14 three sites in 2009 that were on automated critical peak
15 pricing, and we transitioned them to the participating load
16 pilot with PG&E. The participating load pilot was very fast
17 response and we were able to get the sheds in less than a
18 minute. The graphic on the bottom left is the fast Demand
19 Response. We were able to take a site that had been using
20 an infrastructure for day-ahead critical peak pricing and
21 were able to get the sheds in less than a minute. We had
22 four-second telemetry on those sites, and that gives us the
23 confidence that many of these loads can respond very
24 quickly.

25 On the right, you'll see cold winter mornings in

1 Seattle, so we're moving from a time where we focused on hot
2 summer afternoons to any time DR. And that is a big
3 challenge for us to understand the loads in California and
4 how what we've developed for mostly commercial and
5 industrial, and I want to emphasize that the material I'm
6 presenting today is commercial and industrial loads, but
7 we're looking at how do you characterize the CNI end use
8 load for fast Demand Response that's available any time.

9 Now, there are certainly a lot of challenges, and
10 it's very important to be clear about those challenges for
11 Demand Response. The economic incentives need to be more
12 clear, the resource does vary based on temperature and time,
13 and there's not a lot of experience with the midnight Demand
14 Response, what Demand Response do we have in the middle of
15 the night, that's not a key time, those morning ramp
16 periods, which I'll talk about, those are very important,
17 those ramp hours in the morning and the ramp hours around
18 dinner time. The ancillary service requirements for Auto-DR
19 may be higher, they will be higher than the day ahead
20 critical peak pricing kind of things that we've done, the
21 monitoring, the verifications, the telemetry, and we
22 actually are using dedicated networks to push the Internet
23 signal to the site, that is very fast technology. So right
24 now, we've been installing Open ADR Auto-DR systems using
25 the facility's existing Internet system, and I didn't say

1 that earlier, but Open ADR can be sent over many
2 communications, technologies, and we're currently using the
3 Internet for most of the implementations, although we've
4 done demonstrations with others, and we are actually looking
5 at Open ADR over AMI, and things like that. So, the
6 information and the price signal, the information and the
7 signal is what Open ADR is. We send prices and we send
8 reliability signals, so it's a language for these
9 interactions to signal to the end use load to do something.
10 The very last one, the portfolio management, most of the
11 work that we've done so far has been focused on
12 communicating with the facility. We haven't done too much
13 aggregation and load shaping of the portfolio, but clearly
14 that is an important part as we move from understanding how
15 an individual building performs to an aggregated portfolio.
16 But there's a lot of capability with this technology to
17 automate end-use load control in specific geographic
18 regions.

19 So, the methodology we used for this analysis was
20 organized around understanding the electric loads for the
21 commercial industrial sector. We used the commercial end
22 use survey, the CEUS data, which is by building type and by
23 end use, so we know the AD760, the hourly loads for the
24 State of California for offices, hotels, restaurants, and
25 retail, and then, on the industrial side, we looked at a

1 variety of the industrial loads that we thought were the
2 best opportunities for Demand Response. So we looked at the
3 total load and then we looked at what percent of that load
4 is controllable. In the commercial buildings, we have eight
5 years of experience with commercial buildings, and about a
6 third of the commercial floor space currently has an energy
7 management control system. We've been automating the Demand
8 Response using the energy management system, the Building
9 Automation System. So, when we say percent controllable,
10 we're referring to can you get to - is there centralized
11 control? And with HVAC, there typically is in large
12 facilities with lighting, some of them have them, some of
13 them don't. And then, when we go to that HVAC load, what
14 percent can be reduced? So, we come up with estimates of
15 the total capability. We have been looking at the statewide
16 load data, as I said, so we've done the bottom up analysis
17 of which are the loads that we think are feasible for this
18 kind of Demand Response, and we've developed multipliers
19 that look at the renewables integration issues in two
20 categories. We've done a two-hour category and a 20-minute
21 category. The two-hour one is similar to what we've been
22 doing and most of our price response have been four to six
23 hour events, so we'll re-set a thermostat, a zone
24 temperature twice. So, a two-hour duration is a typical
25 short term duration in a sense. A 20-minute duration means

1 that you're going to get it done quickly, within five
2 minutes, sustain it for 20 minutes, and then let it go back
3 to normal. So, we're very careful when we look at an end-
4 use load, whether it can respond on that time scale, and
5 I'll make a couple of comments about that. So, as I said,
6 we've looked at building type, and we've looked at end uses,
7 and then we looked at the industrial loads, and we have an
8 industrial Ag water program in the PIER Program that has
9 been part of our knowledge for that part of our research.

10 I've got my Mac to PC messed up a little bit here on
11 the Auto-DR slides, but here you will see the graph in the
12 upper left-hand corner shows the wind on the Grid, and the
13 blue is the load shape, and you'll see we care about those
14 morning ramp hours and the afternoon ramp hours. So,
15 Automated Demand Response can help shift load to the night
16 time, which I haven't talked about yet, but I'll get into
17 some of the terminology in a moment, so we care about the
18 daily peak load management and the ramp smoothing. The
19 current CAISO programs are reg-up, reg-down, non-spin, and
20 spin. We've been looking at Auto-DR for the top three, not
21 the spin, but the reg-up, reg-down, and the non-spin. So
22 that means these responses have a variety of different
23 characteristics about how quickly we have to see the
24 response, and how long the duration is.

25 Now, this graphic is a plot on the X axis it says

1 advance notice of response, and on the Y axis, it's the
2 duration of the response. The top right programs are the
3 ones we've been doing for many years, capacity bidding, real
4 time pricing, critical peak pricing, peak choice.
5 Typically, a lot of what we initially did was day ahead.
6 When you do day ahead, you can do things like pre-cooling,
7 when you do day ahead, and we're doing large industrial
8 loads, we have one site that is nearly 10 megawatts, some of
9 those industrial sites need advance notice, so they cannot
10 do a 10-minute ahead large shed, they need advance notice
11 because it'll influence their work shifts and their
12 production cycles and things like that. To the left there
13 is the non-spinning reserves and those are very fast
14 notification and shorter duration, and the reg-up, reg-down
15 spinning reserves are even faster and shorter duration.

16 So, we're moving from summer time, day ahead, to any
17 time fast. Shorter durations. So, we're trying to
18 understand what that means for an end use load. We want to
19 know how often you can call it, and what kind of disruption
20 it might have on the process. The bottom slide is one
21 you've seen several times today, already, but I've added
22 something to it, I've added the Demand Response oval because
23 Demand Response has some features that are similar to
24 batteries. At the top, you'll see shed shift charge and
25 discharge. A lot of what we've been doing is shedding, so

1 we actually changed the service level. We changed the set
2 point, we changed the lighting level. But sometimes we
3 shift, and when we pre-cool, we shift. One of the things I
4 used to talk about was at Del Monte, when they harvest the
5 tomatoes, they have to get the tomatoes during the harvest
6 time, nobody is going to stop them, but they make the
7 ketchup year-round, and when they freeze the tomatoes and
8 bottle the ketchup, that's a flexible load, they can do
9 ketchup any time. So there are examples of loads that are
10 flexible. So, the key is, is a load flexible? And we have
11 not fully evaluated all the loads in California for their
12 flexibility. Their flexibility is an issue, but how much
13 advance notice do they need? So, as we explore how flexible
14 end-use loads can be, we need to understand fundamentally
15 what we're doing to the load. When we charge, we are
16 actually using the mass of the building, or the frozen
17 products, and that, we believe, is a very valuable aspect of
18 Demand Response, where we're actually, of course, using a
19 demand-side system to help on the supply-side issues. And
20 that's the most important thing here that I haven't said,
21 but I think you all understand, is that the demand side is
22 getting some information about the supply-side issues, and
23 participating in the grid. So that's a new paradigm here.
24 Now, when we discharge, if we are resetting the temperature
25 of a frozen food product and it's going back to - say we

1 sub-freeze by seven degrees, and now we let it go back up to
2 the original set point, we're actually discharging thermal
3 storage by using the mass of the products.

4 This graphic is similar to what I said, but giving
5 you a little bit more detail. On the left are end uses and
6 the industrial loads. We have HVAC and lighting in
7 commercial buildings, frozen and refrigerated warehouses,
8 data centers, agricultural pumping, and wastewater. We've
9 found actually some wastewater facilities have storage, some
10 don't. So, depending on how flexible they are - their
11 flexibility depends on the storage that they have built in.
12 A lot of it is for stormwater runoff, so Municipal
13 wastewater is an example of a load that may have a lot of
14 storage capability. So, you'll see here modulating vs.
15 on/off. Sometimes we're turning loads off and sometimes
16 we're literally resetting set points and changing at the
17 service level. We're also responding on different time
18 scales. Some of the loads can respond in five minutes, some
19 of the loads take 15 minutes, so this is a - all of these
20 are things we've actually done before, so we have some
21 reference to field studies and scoping studies that provide
22 us with evidence that these are real loads that we can build
23 on.

24 Now, this slide shows you four graphics, the left-
25 hand here is the HVAC and lighting, and then the industrial

1 loads, so we see at the top the highest hour and the lowest
2 hour with today's controls. And then, if we actually
3 improve the controls in our facilities, we are reaching
4 almost two gigawatts of potential for this kind of
5 technology. Today, we are at not quite a gigawatt, and the
6 gigawatt is summertime, and the .25 gigawatts are 250
7 megawatts, that is a wintertime, nighttime capability, so
8 we've been spending a lot of time looking at when do these
9 loads exist and how flexible are they, and what is our back
10 of the envelope, bottom up estimate of the capability.

11 This slide here shows - the blue is the two-hour
12 duration and the red is the 20-minute duration. Some loads
13 can be called very quickly, and we can see the reduction in
14 five minutes and sustain it for 20. Other loads are two-hour
15 loads, and this is the same four graphics I showed you
16 before, but these are the capability by time of day, so the
17 8.8 gigawatts is what is available in the summer on a hot
18 day, and on the winter, with today's control systems, in the
19 middle of the night, we're at about 250 megawatts. And
20 then, when we improve the controls, which allows us to get
21 to the end-use loads, the loads almost double - more than
22 double on a couple in the 1.8 gigawatt case.

23 This is my last slide, and so we're concluding that
24 the initial estimate is something like between 250 megawatts
25 to .8 gigawatts of today's control capabilities. Those are

1 loads that we think are readily available, at a reasonable
2 price point. Those are loads that we've seen demonstrated
3 over the past eight years. We've not done healthcare, for
4 example, or hospitals. We've not looked at hotels. Some of
5 those control systems are more distributed today and not as
6 centralized, but as we retrofit the controls, we're going to
7 be able to touch more of those end use loads, so we're
8 increasing that. There is research to be done on the
9 economic evaluation, which are the most cost-effective to go
10 after, what additional off-peak data are needed to do these
11 studies to better understand and firm up these numbers, and
12 the geographical considerations. We want to do some of
13 these activities near to the problem areas on the Grid. So,
14 that gives you an idea of what we think the capability for
15 automating Demand Response is for these very fast DR
16 resources in California. Thanks.

17 MR. GRAVELY: Questions? No questions at all?
18 Okay. So, we will have a public session here in about 45
19 minutes to answer questions.

20 MR. JAMALI: This is Joseph Jamali, a consultant.
21 You referred to improvement in controls. What are you
22 referring to, specifically?

23 MS. PEITTE: One of the best examples is our
24 increase in the Ag pumping resource. There is a company
25 that is doing a wireless agricultural pumping platform to

1 get to Ag pumping as a load. If you install dimming,
2 lighting, for example, that supports both energy efficiency
3 and Demand Response, your ability touch more lighting
4 increases, so those are two examples. So, all of these
5 increases are related to improving the end-use load control
6 and having better access to controls.

7 MR. JAMALI: How about HVAC?

8 MS. PEITTE: HVAC, definitely. As I mentioned,
9 about a third of the commercial floor space has an energy
10 management system. When you just have rooftop units, you
11 may not have the rooftop units talking to each other, so you
12 have to automate each of them individually, which is more
13 expensive than going to a single centralized system.

14 MR. JAMALI: Okay, thank you.

15 MR. GRAVELY: And Mary Ann didn't mention, but
16 specifically, also one of the values of the ARRA projects
17 and the National NIST efforts is that many of the control
18 companies are starting to consider or are already doing -
19 embedding open Auto-DR protocols into their systems, so the
20 ability to reach more loads and the ability to reach them at
21 a much lower cost is something that we will probably see as
22 a result of the large insertion of Smart Grid money by ARRA.

23 So, I would now like to turn over the opportunity we
24 have now to Albert Chui here from PG&E, he is going to share
25 with us PG&E's perspective on Auto-DR, intermittent

1 renewables, and then, after him, we'll also hear from SCE.

2 MR. CHUI: Hello everybody, I am Albert Chui with
3 Pacific Gas & Electric Company. Thank you, California
4 Energy Commission, for this opportunity to allow us to share
5 our points of view and our vision on how Auto-DR can
6 potentially use for addressing intermittent and renewable
7 issue. So, first, actually, I need to apologize, I was
8 under the wrong impression that the presentation is only 10
9 minutes, so I have only prepared for three to four slides,
10 you know, but I can definitely talk 20 minutes, maybe even
11 more, but if not, you know, I will allow others to have more
12 time.

13 PG&E has started to engage Auto-DR starting in 2006,
14 and in 2007, the CPUC ordered a three-hour use to start
15 engaging Auto-DR activity, and for the last few years, we
16 have offered Auto-DR program to our different customers.
17 And, oh, actually, before I address these questions, I would
18 like to provide an update on our Auto-DR programs. So, at
19 this moment, we have enabled about 45 megawatts of Auto-DR
20 load, and hopefully by the end of 2011, we will have 75
21 megawatts of automated. Both PG&E and Edison are big
22 supporters of the Open ADR standard and, you know, as Mike
23 suggests, it's definitely a necessary thing to do because we
24 want to make sure that there is more control company and
25 more vendors providing the Auto DR service, and technology,

1 so that, in a utility perspective, we can implement Auto-DR
2 programs in a more cost-effective manner. So, both PG&E and
3 Edison are big supports on that. And also, we are working
4 with Honeywell, which won an ARRA funding projects to
5 promote Open ADR technologies within California, and they
6 started at Edison's service territory first, and now they
7 migrating, you know, into the PG&E service territory, so we
8 will definitely plan to work with Honeywell to promote Auto-
9 DR technology to our customers.

10 So, in general, PG&E has two Auto-DR goals, well,
11 obviously, first we want to accomplish the different
12 objectives that, you know, we have outlined to the CPUC, you
13 know, on Auto-DR program, which includes engaging more
14 customers into the Auto-DR technology. But also we want to
15 use the Auto-DR technology to integrate with emerging
16 technology products and, throughout the days, you know, I
17 have realized that a lot of energy storage and permanent
18 load shifting technologies is also considered emerging
19 technologies, you know, on the utility demand side
20 management perspective. So, I think there is this tight
21 integration opportunity, you know, to use Auto-DR for
22 permanent load shifting or energy storage type of emerging
23 technology. And then, also, the second objective of Auto-DR
24 is how we can use the Auto-DR technology and this
25 communication channel, and this open protocol to provide DR

1 resources into a product of the California ISO market. As
2 all of you are aware, PG&E has been, you know, as a matter
3 of fact, California IOUs have been engaging with Demand
4 Response and note management type of activities, you know,
5 for a long time. But throughout the years, there is
6 definitely a gap between the DR resources and California ISO
7 activities. And we feel like Auto-DR would help us to
8 engage Demand Response resources into the ISO market,
9 getting DR resources into the ISO products, as one of the
10 ISO's products such as energy, capacity market, ancillary
11 services market. And now I'm going to talk about exactly
12 how we are going to - the different research that we have
13 done to help us prepare ourselves to look at exactly how
14 we're going to do that.

15 So, as I mentioned, we want to start looking at the
16 technical feasibility of providing the different services to
17 the California ISO to mitigate the following, which is
18 increasing ramping requirements, over-generations, and
19 intra-hour variability. We have done - well, we are in the
20 process of doing one pilot, and we have actually completed
21 the participating load pilot, which was designed to address
22 the feasibility of providing services to CAISO. Okay, so,
23 the participating load pilot that we had in 2009, the main
24 objective was to demonstrate integration with CAISO
25 automated dispatch system with Auto-DR demand response

1 automation server, and the creation of a feedback mechanic
2 system to allow customer response to provide closer to the
3 instructive supply by the CAISO. And in my opinion,
4 actually, that's also one side's benefits, that me and John
5 Hernandez, the Program Manager of that project, have
6 realized, you know, with this pilot is, you know, obviously
7 Demand Response touches on many different areas at PG&E,
8 that includes Demand Response, of course, energy efficiency,
9 Demand-side management, marketing, customers, but then there
10 are actually two major departments that we work very close
11 with, that is sometimes kind of behind the scenes, which is
12 Energy Procurement and Transmission and Distribution. And
13 we work with Energy Procurement when we could tell DR
14 events, okay? Obviously, we need to justify why we call a
15 DR event, and wish the DR event to call which resources are
16 available, and we work with Energy Procurement to determine
17 a lot of those things. And all along, I would say that, you
18 know, it is just because of the activities and the fact that
19 demand resources have not been - that is not a major tie
20 with the CAISO market. Our Energy Procurement looks at
21 Demand Resources as reliability resources, they look at this
22 as - they don't see the tie, you know, they don't see the
23 link between DR and the ISO market, even internally, you
24 know, we have those kind of silos and challenge to overcome.
25 And one of the major - John is doing a very good job in

1 implementing this pilot. At the end of the pilot, Energy
2 Procurement has a different perspective on Demand Resources,
3 okay, we have Energy Procurement staff, you know, internally
4 at PG&E, that starts looking at DR, you know, a different
5 perspective. And I'm sure that there are people that
6 already agree that DR is a good resource, you know, in
7 energy procurement, but definitely this pilot helped those
8 people to ensure that DR, Demand Response resources, can be
9 used for different products in the ISO market, but not --
10 just kind of go beyond the reliability perspective.

11 So, this is an architectural diagram that we have
12 with the participating load pilot. Basically, there is a
13 Demand Response Automated Server that PG&E talks to, and
14 then we are using different technology to get four-second
15 telemetry on the customer side, and the customer drops load
16 on both lighting and HVAC, and we have three customers that
17 have this type of telemetry installed. And, again, the
18 objective is to find out if we can use lighting and HVAC
19 load to participate and bring the DR resources into the
20 market because if, let's say, for some reason we have
21 identified a lot of barrier, right, then we know that, we
22 are maybe a little far from using Demand Response, or Auto-
23 DR, to address intermittent renewable resources, but with
24 the pilot, we have successfully demonstrated that Demand
25 Response resources can be used to drop load, you know,

1 filling all the requirements, except we did ask for one
2 exception, which is I believe the one megawatt exception, it
3 needs to be one megawatt minimum load when we bid into the
4 ISO market, but the fee customer is in a different category,
5 low elevation point, and so we did ask ISO for this
6 exception. But other than that, we have successfully
7 demonstrated that Demand Resources can be used for this.

8 And now I'm going to talk about - this is just one
9 of the graphs that Mary Ann showed exactly what happened on
10 that date, and the blue line is the forecast data, the red
11 one is the hourly forecast with reductions, and the green
12 one is the actual five-minute data. Okay, so with the
13 participating load pilot as a stepping stone, now we want to
14 tackle a more advanced agenda here, is how do we use Demand
15 Resources to address intermittent renewable resources, at
16 least the potential of it? Because, just the system alone,
17 it is a participating load, the IR, Intermittent Renewable
18 resources demonstration, required different system that was
19 used for the participating load pilot. So, not only do we
20 need to look into how to integrate a different system with
21 Demand Response, for example, ISO used ADS, Automated
22 Dispatch System, on the participating load pilot, now we are
23 trying to connect to the AGC, which is the Automatic
24 Generation Control with the ISO. So, there are different
25 challenges to overcome and different technical experience

1 that we need to gain from implementing the different
2 systems. So, again, we want to find out whether the
3 coupling of DR or thermal energy storage can provide
4 regulations for ISO market. We want to integrate the AGC,
5 we have addressed, we want to analyze the optimizations of
6 thermal energy storage and a possibility to provide service
7 and may be able to address the intermittence issue. I do
8 want to point out that, actually, is it on the next slide,
9 okay, well, not yet. Okay, so I do want to point out that,
10 on the Intermittent Renewable resource, what is unique about
11 this specific pilot is that we will be identifying customers
12 that can provide energy storage with - you know, not with
13 the traditional energy storage and the technologies that
14 people demonstrate in the morning sections of today - we
15 want to look at how customer operations such as refrigerator
16 warehouses, and maybe using pre-cooling, okay, as energy
17 storage, with this pilot. When you think about that, that's
18 a totally different concept, right, with batteries, with
19 pumped hydro, and all that, because people have that now,
20 right? This may be the control that is required, but
21 refrigerator warehouses have frozen food now, okay?
22 Buildings have thermal mass now, okay? So, how we can use
23 the existing resources, okay, as energy storage, to look at
24 how we can tap into those resources and adjusting customer
25 energy usage and operations differently, so that we pre-cool

1 earlier, or we pre-cool at a different time, or maybe we
2 freeze the food to different degrees, or to lower or higher
3 degree, based on the time, so that we have a better
4 understanding of how those resources can be used for energy
5 storage. And, interestingly, we are still in the process of
6 identifying customers and working on the pilot, but
7 interestingly, the first things that we kind of realized is
8 that the requirement of a sophisticated operation system on
9 the customer side, okay, what that means is that, if the
10 customer energy management system, or if there is some kind
11 of energy software that can help us to predict, or forecast,
12 or analyze a specific building thermal mass for peak
13 cooling, that is a good type of software. If the customer's
14 operations software can keep track of the potential of the
15 frozen goods, okay, on a specific time, so that we know
16 exactly if the refrigerator warehouse is full, half-full, or
17 in the 50 percent capacity, or in the 25 percent capacity,
18 then we know because we already know the load shift
19 energies, right? So we know exactly how much load is
20 available, okay? So, it turns out that forecasting on
21 customer load for Auto-DR projects, for using Auto-DR, for
22 the Intermittent Renewables, it is all tied together. So, I
23 think we have Auto-DR, which is a good thing a good
24 communication channel, and we are working on the Open side,
25 but I think it was an eye-opening opportunity for the

1 utility to look at what other pieces are missing in this
2 whole picture, so that we can start using existing
3 resources, or existing infrastructure, so that, at the end
4 of the day, it is very cost-effective - well, it is more
5 cost-effective to use DR for Regulations, energy or other -
6 for ancillary service type of measures.

7 So, to conclude, the activities that we have with
8 Auto-DR, we definitely want to use this technology, the
9 program and, again, how we can integrate all the technology
10 together to beat DR resources into the ISO market using
11 positive Demand resource channel, or other types of - an
12 identified channel in the future, and definitely it allows
13 the opportunity to look into different things. After this
14 specific IRR, we will also propose to CPUC an additional IRR
15 project that looks at like a second phase of how we can use
16 Demand Resources to further address intermittent renewable
17 resources, and we are working with - we will propose a
18 permanent load shifting program, depending on the
19 recommendation of the POS study with the Demand Response
20 Measurement and Evaluation Committee, and again, all these
21 activities is to develop low-cost DR resources that can
22 potentially provide products for the client. So, any
23 questions?

24 MR. GAVELY: Questions?

25 MR. CHUI: Yes.

1 MR. JOHNSON: Hi, this is Walt Johnson with KEMA
2 these days. I had a question following on both what Mary
3 Ann was saying about moving Auto-DR to more rapid
4 timeframes, and the second project that you're talking about
5 on integrating AGC with Auto-DR. The push of the signal to
6 the Demand Response Automated Server can happen instantly,
7 and the four-second interval that AGC dispatch is on
8 wouldn't be a problem, but given that the resources poll the
9 DRAS - and originally I think we're polling it like 10-
10 minute intervals -- you could clearly shorten that, it is
11 configurable; but is there a limitation, or do you see any
12 issues with having to poll on a one-second, or maybe sub-
13 second sort of interval? So, is the protocol changing or
14 emphasizing sort of a push alternative to the polling
15 mechanism that has been, I guess, traditional, or the
16 established mechanism in ADR?

17 MR. CHUI: I will let Mary Ann discuss the details.

18 MS. PEITTE: With the critical peak pricing day
19 ahead, it is about every minute polling, as you say; but
20 with this project, it's a one-second push, so it's dedicated
21 Internet, so it is an AT&T Network, right, Ed? Yeah. So
22 it's very fast, one second to the controls.

23 MR. GRAVELY: More questions?

24 MR. CHUI: All right, thank you.

25 MR. GRAVELY: Thank you very much. So now we'll get

1 a chance to hear Southern California Edison's perspective,
2 and Jeremy will introduce that, and then we'll have a
3 question and answer session, but if it's this quiet, that's
4 going to go quick. Go ahead. May be not.

5 MR. LAUNDERGAN: Perfect timing, everyone is just
6 getting to be really relaxed after lunch. I'll try not to
7 pay attention to any snoring. I have to apologize to the
8 audience, I did not realize it was gray suit day. So
9 hopefully you'll forgive me in that. I also have to
10 apologize, I only have five slides, including the
11 coversheet, so we can probably move along relatively quickly
12 here.

13 As we heard with one of the first presentations this
14 morning, CAISO really will be the coordination for covering
15 for Intermittent Renewables. You may have - or they had
16 forecast for sunny days, for a certain amount of wind, and
17 you have more clouds or the wind doesn't blow. I'm actually
18 a sailor, so I know the whole thing about the wind not
19 blowing when you want it to. So, through the various
20 markets that CAISO has, they can then trigger other
21 resources to fill in for the ones that don't show up
22 according to schedule. Specifically, in the short time
23 frame that we're talking about here, you have ancillary
24 services. Now, for Demand Response, over the last couple of
25 years we've worked closely with the other IOUs, CAISO, and

1 other stakeholders to bring two product offerings to bear,
2 really, starting this year. I guess the market for Proxy
3 Demand Resource became available in August after FERC
4 approved the tariff modifications in July, and we're getting
5 to the last bit of a similar approval process for the
6 reliability Demand Response product, so those are two ways
7 that the Demand Response resources are going to be able to
8 play directly in the wholesale market. So, specifically, a
9 Scheduling Coordinator that represents a PDR Demand Response
10 resource can bid into the day-ahead energy market, okay,
11 that doesn't do us much good for intermittent renewables,
12 day-ahead in real time non-spinning reserve market - ah, now
13 we're talking, five-minute real time energy, yeah, that's in
14 there, too. And eventually the HASP, which can also kind of
15 suit if it looks like the renewables won't be delivering for
16 their entire scheduled sequence. So, one of the things that
17 we discovered almost by mistake when we did our pilots two
18 years ago was about the contingent flag. I misunderstood
19 what that meant originally, and John Goodin who is here in
20 the audience set me straight, but a contingent resource that
21 you bid in is a resource that is sitting there and will show
22 up if something else really doesn't perform as it is
23 scheduled. So, with a contingent resource, a contingent
24 ancillary service resource, would show up if another
25 resource doesn't perform as scheduled. So, in the case of

1 an intermittent renewable, what you might do is take a
2 limited resource Demand Response product, something that
3 could only be dispatched, say, 12 times a year, or 700
4 minutes a year, whatever you might have for constraint, and
5 register that as a contingent resource, then it would become
6 an available resource in the wholesale market if something
7 else, either an intermittent renewable, or even conventional
8 generation, doesn't perform as anticipated. This mechanism
9 could be used for any type of resource not performing.
10 However, as we've also been working with the other IOUs, as
11 well as CAISO, there are some pretty big challenges to
12 Demand Response actually playing in ancillary services. The
13 big one is the telemetry. So, in order to play in the
14 ancillary services market, you need to near real time
15 monitor the availability of that resource and what it can
16 deliver, and what that translates to is a four-second
17 refresh from whatever aggregation point is with the one-
18 minute refresh from each and every end point. So, we've
19 been spending a lot of time looking at different
20 alternatives for doing that. Albert was talking about some
21 of it and we're looking at some Internet back polls, instead
22 of having the dedicated telemetry solutions, which, by the
23 way, can run \$30,000 a year, and for every air-conditioner
24 out there for our programs, that's probably not very
25 affordable. So, we also have the five-minute settlement

1 requirement for basically the near real time type of
2 markets, including, I think, HASP has a five-minute
3 settlement, and we're deploying our Edison SmartConnect, as
4 well as our current RTM meters for large commercial
5 customers, those have 15-minute intervals for commercial and
6 industrial customers, and one-hour interval for residential.
7 So, one of the proposals is, well, just take that 15-minute
8 interval, divide by three, and then you've got three equal
9 segments of five-minute intervals. Sounds good until you do
10 the math and that kind of under-estimates your performance
11 by 15 percent, on average. So, those are some of the things
12 we're working really closely with CAISO to figure out, and
13 also for residential customers, because one of our largest
14 resources, actually air-conditioning cycling, where we've
15 done a lot of testing, and currently we have 350,000
16 customers with 450,000 devices, providing 750 megawatts in a
17 program operational today. So, that's where I've been
18 spending a lot of time over the last two years, seeing how
19 that resource can make itself available in the ancillary
20 services market, to address, in part, intermittent
21 renewables. So, with a one-hour interval, what can we do
22 with that? Well, we also have existing SCATA systems that,
23 oh, by the way, already provide that four-second refresh,
24 and also provide aggregated metering points for everything,
25 say, underneath the distribution substation, we're

1 completing that research right now, and that report will be
2 filed with PUC at the end of January.

3 And there is also the challenge of actually figuring
4 out how to reconcile the retail market, the customer
5 compensation relative to the CAISO wholesale market. The
6 issue here is that CAISO doesn't run a capacity market, a
7 lot of the DR value currently is through capacity that is
8 determined through resource adequacy. As a result, resource
9 adequacy payments for Demand Response are outside of the
10 wholesale market, and therefore it becomes challenging to
11 actually come up with the retail compensation that includes
12 the capacity value from resource adequacy, as well as
13 whatever energy payments come from the CAISO wholesale
14 markets. Some of those issues will hopefully be tackled in
15 the CPUC DR Order Instituting Ratemaking Phase IV, Part Two,
16 which just came out, I think, last week, and I was spending
17 all day Tuesday replying to some of their very good
18 questions associated with that. I encourage people to
19 participate if they're interested in some of that question.

20 So, earlier we heard from Mary Ann and Albert on
21 Auto-DR, I'm actually going to take it a little bit more
22 generic. Automated Demand Response just being something
23 that is triggered automatically, regardless of protocol or
24 anything like that, or customer segment. And what we need
25 is something to be able to react quickly, it's got to be

1 automated, and the old way of saying, "Hey, you're on
2 critical big pricing and it's critical peak day, and you
3 call the person, or page the person, and they run around
4 turning off lights in their factory, that just won't work
5 for this. So, it's got to be automated, and it's got to be
6 relatively quick. We use Open ADR that Mary Ann was talking
7 about, which uses the Internet for the communication for our
8 larger commercial and industrial customers. We are also
9 deploying a advance metering infrastructure system that
10 we've branded Edison SmartConnect, which will be using
11 Zigbee Smart Energy profile, and we're anxiously awaiting
12 Version 2.0 to address some security concerns and others, as
13 well as just robustness of the protocol. So, that will be
14 addressing our residential small and medium commercial and
15 industrial customers. We actually expect that some
16 customers that start getting introduced to Auto-DR through a
17 Smart Energy profile will want to, say, graduate to a little
18 bit more robust stack in the Open ADR, so that is something
19 that we're going to be working with our customers on, but
20 either way, those are two automated ways of dispatching to
21 customers to react to wholesale market signals, there may be
22 some latency on the AMI network, we won't know until that is
23 fully deployed. So, we know that our current AC Cycling
24 Program can respond well within the five-minute, we've done
25 multiple tests over the last, what, probably four or five

1 years, including the spin or reserve pilots that we've done.
2 But, as each of these technologies get deployed, we need to
3 determine the latency to make sure it can actually meet the
4 five and ten-minute dispatch instructions.

5 And we're embracing the Open Standards, as Mary Ann
6 also mentioned, Open ADR and Smart Energy Profile 2.0, both
7 of which are identified by NIST, so there are a lot of folks
8 out there going, you know, "Go now! We've got a solution,
9 plug and play, off we go!" But, we really need this stuff
10 to be open Standards because we cannot have a vendor lock
11 and any sort of large scale deployment of something would
12 only have a sole source deployment, that's not really
13 sustainable in the future.

14 So, from a process standpoint, this would be the
15 process for Demand Response actually reacting to ancillary
16 service signals from CAISO, and this is the exact process, a
17 little bit higher level than the actual process, that we did
18 for the pilot two years ago. We had real time telemetry
19 monitoring, we actually used the sample monitoring for that,
20 sent that signal both to our back office, as well as CAISO.
21 We bid the load into the day-ahead market, we received
22 dispatch instructions from CAISO, those instructions were
23 dispatched to the AC cycling, we measured the load drop, and
24 then we settled. Now, for the pilot two years ago, we were
25 using the AC from a military base, and we had 3,200 air-

1 conditioners out there, on a good hot day, that's five
2 megawatts, it went like this [snaps]. So, this is about
3 five megawatts at the drop of a hat. What we did here was
4 what we call 100 percent cycling with no randomization, it
5 was literally like hitting a light switch, turned them all
6 off, turned them all back on, all at once, I did that type
7 of a deployment because I wasn't exactly sure that we'd be
8 able to see it, boy, was I wrong. So, that little hump that
9 you see after the Demand Response to restoration, that's
10 what we call a "rebound," the reason that you do the
11 randomization is so that you minimize that rebound, and you
12 can do randomization over a five to 10-minute timeframe so
13 that it's more of a ramp, rather than suddenly an instant
14 restore, and suddenly every single air-conditioner is trying
15 to catch up with itself.

16 This year, we did more general population testing at
17 12 different substations, so we used the test provision of
18 our summer discount plan AC cycling, did two tests per
19 substation for 24 events, total, combined that with all the
20 findings from our production events. We had two system-wide
21 events plus around four districts, how many nine events,
22 that's out in the Palm Desert area where the system is a
23 little bit constrained, and high load in the summer. So, we
24 have a lot of data that we're crunching and, like I said,
25 that report will be made available in January, along with

1 our DR filing for funding for the next cycle. So, a lot of
2 data, we're going as fast as we can, and look forward to
3 continuing working with CAISO, the other IOUs, and hopefully
4 CEC in figuring out how all this works.

5 MR. GRAVELY: Questions for SCE? No questions? So,
6 I also would like to point out, this question has come up
7 several times on Auto-DRs and Ancillary Service, and that is
8 telemetry, I've thought a lot about it and discussed a lot
9 about it, there are some values to already being on the
10 loading order, and DR is at the top of the loading order
11 right next to energy efficiency, so sometimes you can get a
12 get out of jail free card for that - I'm trying to figure
13 out what that means. But I do believe there is some
14 opportunity in Auto-DR if we can demonstrate the capability
15 and not assume the cost of direct two-way communications,
16 but an alternative, very reliable estimating ability that
17 could be revenue quality, and I think there are some options
18 out there. Certainly, there are vendors who want to sell it
19 to me. I think that there was some opportunity to do this
20 in Auto-DR without having to have the two-way communications
21 like we have currently in most systems, and that's one of
22 the challenges that Mary Ann is also looking into, is how do
23 we handle the telemetry, how do we handle the settlement,
24 and how do we handle the verification.

25 So, we've had a busy day. I'd like to throw it out

1 for questions here first, comments, most of the speakers are
2 still here, I'll try the online next, and then I've got a
3 couple closing questions, actually, to make the most out of
4 today's workshop, and to help us prepare for the next IEPR
5 workshop and other efforts.

6 So, does anybody here have questions or comments for
7 any speaker, or for us, in general? Nobody in the room has
8 questions, no comments? Okay, go ahead and open up the line
9 because they've been very patient - oh, go ahead. I'll take
10 the questions here first, and then we'll go online.

11 MR. MILLER: Rick Miller with HDR. A lot of the
12 discussions today showed slides of the future with solar and
13 wind, and the load is not concurrent with demand, but it is
14 relatively smooth curve. That's not what Bonneville is
15 seeing, they're seeing 2-3,000 megawatt ramps per hour,
16 routinely - every week. That's at 3,000 megawatts of wind,
17 they're projected to see 6,000 in three more years, a lot of
18 that balancing will have to be provided by California
19 because that wind is being shipped to California, in
20 addition to your native supply that is ramping, how is that
21 being factored into your long range plans? I don't see
22 those ramps and that system - this system variability being
23 factored in into the load curves that are being projected?

24 MR. GRAVELY: Well, two things, one is I would agree
25 with you in general because I've been trying to find ways to

1 document that with research, identify that. The first time
2 we were very successful with the KEMA Report, we're doing
3 follow-on work to that. We do have load modelers here
4 within the Commission that do modeling, in addition to load
5 modeling experts that we can contract with, so I would leave
6 it in general for today as one of the questions, and that is
7 what is a realistic estimate of the ramping requirements and
8 the load requirements of 2020 when we reach our 33 percent.
9 We, obviously, have a comment in NIST, but the ISO is
10 responsible for doing their studies and working there, we do
11 things to help them do that, the utilities are responsible
12 for meeting their piece of that, so I think what has
13 happened in the last year, at least in my mind, is a
14 realization that the problem is bigger than we thought maybe
15 two years ago, and we're starting to see that information.
16 I think, as we get smarter and learn more, that number could
17 go up. But what we're trying to do is provide options to
18 address that also at the same time, from that area. So, I
19 don't disagree that the challenge could be bigger than we
20 portrayed today, I think the challenge as portrayed today is
21 a pretty monumental challenge to put systems operating in
22 time given, you saw some timelines for projects that are
23 already 2017 or later, so I think that's something we have
24 to work - certainly an area that we're interested in trying
25 to quantify, trying to present to our Commission, trying to

1 present to the Public Utilities Commission, to have to make
2 these long term planning decisions, certainly. We see in
3 our IEPR, there are estimates - you've seen presentations of
4 different types of scenarios of high integration, low
5 integration, different things, so we do those. For those of
6 you who are online and here, if you have information you can
7 share with us to help us understand, if you have examples,
8 you know, the Texas example is used a lot of what happened
9 there in their wind - the value of forecasting, whether it
10 be for renewables, or for DR, was brought up today, and
11 that's another element we'll take home with us to work on.
12 So, I would tell you that I think we understand the problem,
13 I don't think anybody here is prepared to quantify it
14 specifically, but I do think it could be worse than
15 estimated, but we need to find ways to do some analytical
16 studies and come up with numbers that multiple parties can
17 agree with, and then also respond to.

18 Ultimately, our goal here and the research that we
19 do is to provide answers to the policymakers in our case,
20 and the PUC, and the ISO, and ARB, and other places that
21 worry about these issues, have the information so they can
22 set policies for the future that are consistent with what
23 we've done, and address the issues that we have from there.
24 So, I would welcome any information you have of the kind of
25 ramping rates we're seeing in Bonneville, so we can use that

1 in our studies, and any other models or things you might
2 recommend for us to look at or do some analysis with,
3 certainly not in the next couple months, but over the next
4 few years, we can do that. Go ahead.

5 MR. ALVAREZ: Tony Alvarez with PG&E. Udi Helman
6 left already, but just to make people aware, that there is a
7 33 percent integration study going on, which is sponsored by
8 the ISO. There is a working group also working with the
9 ISO, we are part of the working group, Southern California
10 Edison is, and a number of other parties, and if you follow
11 the links that Udi provided today, you can find estimates of
12 the amounts of incremental regulation, load-following,
13 ramping that is required for different scenarios of the 33
14 percent. So, I'm hoping that the California Energy
15 Commission can take advantage of that and, you know,
16 leverage the work that has been done there, just put a plug
17 also for PG&E, we have a model, simple spreadsheet model we
18 put together to do similar calculations of incremental
19 amounts of Regulation load-following, and unit commitment
20 that is required for different levels of wind and solar
21 generation in California. So, if you follow the links that
22 Udi provided, you can find those estimates there. So, we
23 will be updating the analysis using the new Renewable
24 Portfolio Standard scenarios that the California PUC is
25 planning for the long term plan -- for this 2010 long term

1 plan cycle.

2 MR. GRAVELY: Okay, thank you. Other questions.
3 Okay, so I'll go ahead, we have a question here for Frank,
4 if you want to come up. It says, "Question for Distributed
5 Storage Presenters," Frank is one of them, "...How do you
6 define community energy storage in terms of size and
7 distribution vs. transmission size of the breakers?" So, I
8 guess, what do you define as distributed storage, and, if
9 you would, since you kind of represented the Integrative and
10 Distributed Industry, I guess the question is, in your mind,
11 as a distributed resource provider, how do you define
12 distributed resources vs. transmission resources, given the
13 fact that, at the end of the day, you're providing 53
14 megawatts of transmission resource?

15 MR. RAMIREZ: A distributed - wow - for us, the grid
16 scale nature of our distributed resource is realized through
17 the aggregating enablement of our Smart Grid platform. For
18 us, our - the amount of storage that we're able to deploy is
19 a function of the number of air-conditioning units to which
20 our storage module can be appended to. Each one of those
21 storage units has an embedded controller that communicates
22 with the other units on a building, but more importantly,
23 tie back up through our NOC to the utility in a secure PI-
24 to-PI communication. That aggregation enables the utility
25 to look at that distributed resource in the same way that

1 they would look at any generating resource on their system,
2 whether it be a 25, 50, 75, or 100 megawatt gas-fired
3 peaker, which is the resource that we make either
4 unnecessary to run, or unnecessary to build.

5 MR. GRAVELY: Okay, thank you. Go ahead. So we'll
6 take the questions in the room here, then I will try opening
7 up the mics for people to call in or a couple questions
8 here, and if you didn't hear your answer because of the
9 mics, we'll try to fix that, too. Charlie, do you have a
10 question?

11 MR. VARTANIAN: To add to Frank's answer, on the
12 size and connection, I'd like to point to the American
13 Electric Power Open Source Spec for Community Storage that
14 discusses one utility's vision of a primary distribution
15 connected device, 25 kilowatts, 25-50 kilowatt hours. EPRI
16 is helping to broaden the involvement and get other
17 utilities contributing to that Open Source spec, but that
18 gives a good description about at least one form of
19 community energy storage that is pretty well defined by ADP.
20 I think a distinction there is connected to the primary
21 distribution asset, not to the network grid, so
22 categorization from a FERC, TDG, split standpoint.

23 MR. GRAVELY: And would you just repeat the size?

24 MR. VARTANIAN: A 25-50 kilowatt hour, or actually
25 the capacities that are first being deployed in the early

1 demos, but the spec actually widens that range a little bit,
2 but the first actual physical deployed systems I know of are
3 25 kilowatt hour to 50 kilowatt hour - 25 kilowatt hour
4 rating, or another way, 25 kilowatt hour rating for one to
5 two hours.

6 MR. GRAVELY: EPRI agrees, concurs. Comments or
7 questions from the room? Okay, we'll try this first, and if
8 it works, we'll let people speak up, if not, we'll have you
9 raise your hands on the WebEx and we'll call you. But go
10 ahead and un-mute everyone. And we have a question from
11 Carl Lenox, you can try first, Carl, if you're on the line,
12 would you go ahead and ask your question?

13 MR. LENOX: Sure. Can everyone hear me?

14 MR. GRAVELY: No, we're getting an echo, but go
15 ahead.

16 MR. LENOX: Okay, I'll try to do that. Starting
17 with the comment, if you look at the Red Electric's System,
18 the Red Electric, it's strikingly - their current mix and
19 capabilities in terms of storage, hydro, and then I'm seeing
20 pumped storage, their generation mix, the size of their
21 system, it's strikingly similar to where California wants to
22 be in the high renewables case in 2020. And it's sort of a
23 very different operating reality than, I think, some of the
24 modeling shown in terms of sort of these nascent emerging
25 problems, they're actually doing it, they're actually

1 managing it. They have almost 19.4 gigawatts of wind, they
2 have 3.4 gigawatts of PV on their system, and they're
3 operating it. So, I was wondering if we could get maybe
4 some perspective on if there are any really significant
5 differences there, is there something going on there that is
6 not possible to do in California? Or, is it just simply
7 that we haven't reconciled the modeling with the actual
8 operation of this particular system and other systems with
9 larger penetrations of renewables than we have here in
10 California?

11 MR. GRAVELY: I'll turn to one of the other
12 speakers. I'm afraid I don't feel qualified to answer that
13 one. Any of the speakers here want to answer that?

14 MR. MILLER: I can answer part of that. Rick Miller
15 at HDR. Spain has a very distributed wind and solar
16 portfolio compared to the U.S. markets, so they're able to
17 get benefits of diversity in location. They also have a
18 very unconstrained, flexible generation system, they have
19 about 4,000 megawatts of hydropower that has no constraints
20 on it, unlike the Columbia River system or most hydropower
21 systems in the U.S. And the other is, they're building
22 about 1,500 megawatts of pumped storage, so that's
23 aggregating it altogether is what Spain is doing to address
24 their problem.

25 MR. LENOX: To be fair, though, I've actually had

1 discussions with Red Electra, they consider all of their
2 hydrogen to be constrained and, in fact, can't depend on it
3 for flexibility in the late summer, I was told that by the
4 System Operator. And to be fair, I mean, I'm talking about
5 the system that is operating today, obviously to get a
6 higher level of penetration to meet our 2020 goals, we're
7 going to have to do more, right? But where they are today
8 is our high case in 2020.

9 MR. MILLER: You make a good point. They do - its
10 challenge about do they have enough fuel, do they have
11 enough water for enough generation throughout the year, but
12 their actual operations and their operational flexibility is
13 unconstrained. But they're actively building grid-scale
14 storage, they're implementing a number of things that are
15 being studied here in the States, they're actually
16 implementing it as part of an overall integrated resource
17 plan.

18 MR. GRAVELY: Thank you very much.

19 MR. LENOX: Yeah, no question about it, right? But
20 they're also currently operating the system without those at
21 their current levels of penetration, which are levels of
22 penetration that we're only talking about right now, so,
23 anyway, I just wanted to get that comment out there, and if
24 there's anything that we can do to sort of bring that
25 operational reality to bear, particularly in these modeling

1 exercises, I think that would be useful.

2 MR. GRAVELY: So any reports, presentations, or
3 documents you would like to send to the docket so we have
4 that information available to review would be useful. I'll
5 end up with it, but the Docket address is in the
6 announcement that you got the WebEx information from. Next
7 speaker here from the ISO.

8 MR. GOODIN: This is John Goodin with the California
9 ISO. I met with Red Electra a couple weeks ago, two or
10 three weeks ago, and there is a distinction that makes the
11 difference between how they count renewables vs. how
12 California will be able to count, and that is that they
13 actually get to include their large hydro, whereas
14 California does not, and that is a significant difference -
15 a 33 percent without our hydro system is a huge difference
16 between Spain; in fact, if you were to include our hydro
17 system with our current wind and solar, we're actually
18 operating at a very similar paradigm to Spain today. So,
19 that is a big difference. They do have a lot of diversity
20 that we don't seem to have as far as their wind resources in
21 Spain, as well. We have very concentrated areas with wind;
22 theirs seems to be spread out throughout the country. So,
23 anyhow, but I think the hydro is a significant difference.

24 MR. GRAVELY: Thank you.

25 MR. LENOX: It is, just to clarify my comments, in

1 terms of the levels of penetration, I was speaking mainly
2 about the wind and solar, and recognizing that sort of the
3 total amount of hydro in the system there is similar to
4 ours, even how we count relative to an RPS or not may be
5 different, but in terms of total quantity, it's more, I
6 believe.

7 MR. GRAVELY: Okay, thank you. Other questions
8 online, just identify yourself and ask your question.

9 Okay, so what I would like to do is a quick summary,
10 and then I have a couple of questions for going forward. In
11 general, I would like to thank everyone for participating
12 and for speaking today. I would agree with Robert, this is
13 a very great group to listen to. For the purposes of
14 establishing the technology, I think we have established
15 that storage technology, some are available right now as we
16 speak, some are available soon, and some are being
17 developed, so we have options. One of the things I'll also
18 offer, Merwin Brown is in the room here, I mentioned
19 earlier, he was here, I think, when we mentioned, he works
20 for CIEE and he is the Regional Manager for the office here,
21 but we will be doing that vision for storage, Avtar will be
22 the project manager, but CIEE will be the executor with some
23 of the universities and their help. I suspect that we will
24 probably need to have a workshop, public meeting in the
25 January, or early February timeframe, so those of you that

1 are interested in participating in that development, of that
2 effort, again, it will be a four to six months effort, so
3 it's not going to be really long, but we are trying to
4 capture information and trying to make that vision as useful
5 as possible, so I would encourage you to contact either
6 Merwin Brown at CIEE, or Avtar Bining here at my office if
7 you're interested in helping us with that effort. We are
8 very much interested in producing something that is useful
9 for the industry and the regulators at the same time.

10 The other comment I'd have is a question and I'm
11 going to throw it out, I've heard this probably for the last
12 year at different meetings, and that is the comment that
13 energy storage should be added to the loading order, and so,
14 given the fact that the loading order is an energy
15 procurement device, where we're procuring first energy
16 efficiency, then renewable energy, and then advanced
17 generation, and clean generation, and then fuel generation,
18 or coal, whatever it may be, non-clean generation, I guess,
19 is the term, is there anybody here who could help me
20 understand, if we were to consider adding energy storage to
21 the loading order, how would you define it to fit the
22 loading order definition today? And trust me, I've been in
23 Storage for 20 years, it's not like I have an answer, I'm
24 asking a sincere question, if that is something we would
25 want to advocate. And it has come up many times, it came up

1 in the development of the AB 2514 and other times, and so,
2 if we were trying to do that, and trying to find a way to
3 convince the agencies in the state that manage the Energy
4 Action Plan, to add energy storage, how would you define it
5 such that it is consistent with the other definitions that
6 are in that loading order? Robert?

7 MR. SCHAINKER: Yeah, Robert Schainker, EPRI.
8 That's an excellent question. I've given it only a little
9 thought, and I'm sure I won't be finished thinking about it,
10 but it would seem that the loading order methodology for
11 storage should include not only the sort of myopic arbitrage
12 kind of ordering that you can do today, because it's just a
13 cost-based thing, but include some of these - maybe all of
14 the societal benefits, and particularly if we have CO₂ rules
15 in the State of California, which we've talked about and I
16 think will be occurring, there are societal benefits, and
17 reliability benefits to add a shock absorber to the system,
18 either to be small or large. So, I would say that we need
19 to include some of these, or maybe all of them, at least in
20 our thought process, these societal or California benefit in
21 the ordering process. So, that requires a new methodology.
22 I wouldn't - one of the things Tom Edison said years ago
23 was, "The greatest thing you should not do is to think
24 incrementally." You've got to think in step functions. And
25 I think this gives us an opportunity to re-think the loading

1 order process and to really start off with a clean sheet of
2 paper and really do it right. I wouldn't want to just add,
3 you know, sort of cajole it into the existing process, I
4 think we should really think through the whole process all
5 over again, that's my going in thought process.

6 MR. GRAVELY: Other comments? Come up to the mic so
7 everybody can hear you.

8 MR. CAZALET: Ed Cazalet, Megawatt Storage. I think
9 you keep it pretty simple. It's a device that takes in
10 electricity and returns it to the Grid, and it's got a
11 number of megawatts and a number of megawatt hours, and
12 that's a storage device. As we look at DR, it's already in
13 the loading order, it's a rather complex product, and we're
14 able to define that product well enough to put it in the
15 loading order, so you do it the same way.

16 MR. GRAVELY: Okay. Thank you. Charlie.

17 MR. VARTANIAN: John Goodin had a great question
18 that, if CESA is still here, would be great to respond as a
19 group. But a couple quick thoughts and arguments for a form
20 of incrementalism. The SGIP included storage by buying and
21 getting to other qualifying resources. To the extent
22 storage covers otherwise curtailed or spilled wind, could be
23 a great argument. To the extent that it hybridizes either
24 fuel to a case or a battery in conjunction with other fossil
25 forms, that might be a qualifying metric, if it's going to

1 be, let's say, classified a resource is a threshold issue.
2 But these are just initial thoughts. I do want to go back
3 to CESA and some other collective groups and this is worthy
4 of a better formulated response.

5 MR. GRAVELY: Okay, thank you. Comment online,
6 anybody have any comments online? Okay, so I will close up
7 with one thought here I'd like to get some comments on, and
8 that is, if we look at the next workshop being focused on
9 policy, we've had these discussions, during the last IEPR,
10 we had these discussions at several workshops during the
11 development of AB 2514 and other activities, so, for those
12 of you that are out there who will receive the most benefit,
13 the providers of energy storage, or the supporters of energy
14 storage, what policies, recommendations, or actions would
15 you like to see us be discussing in a public forum six
16 months from now? So, this is kind of reiteration of what
17 are the issues that we need to address? I think I know lots
18 of them, but it would be nice to have them on the record
19 from those that are the Energy Storage providers that are
20 trying to provide those services to solve their problems.
21 So, what would you consider the key issues that we should be
22 addressing in preparation for that policy recommendation
23 workshop? Anybody who wants to address it, feel free.

24 MR. SCHAINKER: Yeah, Robert Schainker, EPRI. One
25 of the stakeholders, and I do call them a stakeholder, is

1 not in this meeting that I know of, is regulators. And I
2 would suggest one piece of the answer to your question is
3 that we need to bring some regulators into the discussion.
4 There are just so many different legacy regulations out
5 there, and that is based on old technologies, and we've got
6 new technologies, a whole gamut of them, I think we need to
7 get the regulators involved in the process of looking at
8 these different policies. The other thing I would do, and
9 this is because of our bad experience here in California, at
10 least in my interpretation, is that before we make new
11 regulations, and implement them, let's use our engineering
12 know-how and our simulations of markets, or whatever, let's
13 try it out on some simulations before we actually just put
14 it into our system and then figure out did we really screw
15 up badly, we wasted billions of dollars, before we add any
16 regulations, whatever, pro or con, for grading these
17 technologies, let's give it some simulation talent, I think
18 we've got great resources here in the State of California,
19 private as well as public agencies, and do it carefully this
20 time.

21 MR. GRAVELY: Okay, thank you.

22 MR. RAMIREZ: If I may, Frank Ramirez, ICE Energy.
23 It would be extremely valuable if the analysis that we did
24 was system-level analysis. More often than not, when the
25 analysis is done, it is site level because it is easy to

1 understand, it is easy to measure, and it's led to some
2 pretty good changes in technologies. But it is only system-
3 level effects that actually enable us to understand and to
4 see through what the value is and a failure to look at that
5 leads to reverse consequences.

6 MR. GRAVELY: Okay, thank you very much. Very good
7 comment. In fact, I'll share with you that part of the work
8 that we're looking at doing for the Vision Statement is some
9 modeling work that CESA has been doing and been discussing
10 with the Lawrence Berkeley National - I guess UC Berkeley.
11 But they have some modeling capability that they apparently
12 can help us estimate different mixtures of storage based on
13 some modeling they've done for other applications, that
14 could be adapted for storage, is what I've heard, so we're
15 trying to find that out as part of this research effort, to
16 see if it can help us understand what type of mixture of
17 storage would best meet the goals and the needs of 2020.
18 Other comments?

19 MR. CAZALET: Ed Cazalet with Megawatt Storage
20 again. As we put more and more renewables on, we're moving
21 from a Grid that was designed for fossil fuel, centrally
22 coordinated, into something that has many many resources
23 that are distributed, that need to be coordinated, they
24 can't be centrally dispatched. In fact, it's very difficult
25 to even control them remotely, so then what that means is

1 you have to set up the pricing systems that the rates people
2 receive for residential storage, for commercial/industrial
3 storage, such that they're operated efficiently. And right
4 now, I think everybody is kind of negative about actually
5 moving to some kind of dynamic - fully dynamic pricing in
6 California because of the Legislature. But, by 2020, there
7 is room for much more of that, so if you think carefully
8 about how do you incent the proper operation, the proper
9 investment in storage at the right levels of the Grid, it
10 doesn't come through participation in ISO markets, where you
11 have to bid in storage, no end-user is going to bid into an
12 ISO market, they are not going to bid in their Demand
13 Response, they need to see price signals come to them that
14 allow them to decide what to do. So, I think we've got to
15 re-think from end to end how we interact with the ISO, how
16 we interact with the end-users, and what those signals are,
17 and then how we work with the Legislature and the regulatory
18 bodies to get the right kind of pricing signals into the
19 ratemaking, into the tariffs, that we can utilize both
20 Demand Response as a price-based Demand Response and storage
21 as part of the balancing of real time renewables. So, when
22 the wind stops suddenly, and I think it is going to be much
23 worse than what we see in the data right now, that you get
24 that response from the combined action on the demand side,
25 and all of the supply side, and demand side storage

1 instantly through price signals can travel very very
2 quickly. And without trying to second guess what is going
3 to be there and what the right control signal will be,
4 that's all on the client side, and through very standardized
5 pricing signals, we can have a very powerful coordinated
6 thing where, you know, the ISO is part of that process.

7 MR. GRAVELY: Thank you. Questions online or
8 comments online? Okay - oh.

9 MR. GOODIN: This is John Goodin with the California
10 ISO. I just want to second what Ed just said there, that we
11 do believe that that is the significant part of the
12 solution, is being able to communicate prices that reflect
13 Grid conditions, all the way down to the end-users and the
14 end-users. And that paradigm is what is really going to
15 drive and help with the further integration of renewables.
16 Like Ed says, not everything - and this may come as a
17 surprise - but the ISO, from the Demand Response
18 perspective, doesn't believe that every demand resource has
19 to be integrated, operated, dispatched, settled to the ISO
20 market, that is not correct, the ISO believes that dynamic
21 pricing is the solution - that's the number one Demand
22 Response solution. Does it mean that we don't need some DR
23 that is integrated in the wholesale market? No, we need
24 some. The ISO is a balancing authority, and so long as the
25 system has some level of central dispatch and control, that

1 there is going to continue to be needs for balancing
2 resources and for ancillary services like we talked about
3 today. And so there will be a need for some DR that is
4 configured in a high-quality, high reliability type of
5 resource, gen comparable resource, from the demand side.
6 But, again, I do second what Ed is saying. We need to
7 advance the policies at the Legislature and the CPUC to try
8 to get a dynamic pricing regime in place that is much more
9 robust and must less anemic than critical peak pricing. In
10 the ISO's perspective, critical peak pricing is the most
11 anemic, most innocuous form of dynamic pricing, and if you
12 have the two book ends of critical peak pricing all the way
13 to real time pricing, the ISO wants to move and slide that
14 policy much further to the right than remaining at critical
15 peak pricing. It's got to move to real time pricing, or
16 something of that ilk.

17 MR. GRAVELY: Okay, thank you, John. Comments?
18 Okay, any comments online. All right, well, thank you
19 everybody for participating today. We look forward to
20 hearing from you. Again, those interested in participating
21 for the next workshop we have for IEPR, check with myself or
22 Avtar on the Vision work, and thank you all for
23 participating. Do you have the chart that shows the
24 address? So, on the announcement that you all use to get
25 here is the address, we welcome comments through the end of

1 the month, recommendations, comments, questions, information
2 about the state of your technology if you are a vendor,
3 again, one of the purposes of this workshop is for us to be
4 able to prepare a document for our Commissioners as part of
5 the IEPR to identify how the state of energy storage has
6 changed in 2011 from where it was in 2009. And we're going
7 to do that based on information from this workshop and what
8 we get from those of you who participate. So, thank you
9 all. Have a good day, and I'll see you next time.

10 [Adjourned at 3:45 P.M.]

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