STATE OF CALIFORNIA — THE NATURAL RESOURCES AGENCY ARNOLD SCHWARZENEGGER, *Governor*

CALIFORNIA ENERGY COMMISSION
1516 Ninth Street
Sacramento, California 95814
Main website: www.energy.ca.gov

In the matter of,) Docket No. 11-IEP-1N
)
Preparation of the) NOTICE OF STAFF WORKSHOP
2011 Integrated Energy Policy Report) RE: Technologies to Support
) Renewable Energy Integration

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

The California Energy Commission staff will conduct a workshop to share information and solicit comments on technologies to support renewable energy integration such as energy storage and automated demand response (Auto-DR) technologies as a part of the *2011 Integrated Energy Policy Report* (2011 IEPR) relating to energy systems and renewables. This work is overseen by the Energy Commission's IEPR Committee, Chairman Karen Douglas, Presiding Member, and Commissioner Jeffrey D. Byron, Associate Member. While this is a staff workshop, Commissioners may attend and participate.

TUESDAY, NOVEMBER 16, 2010
Beginning at 9 a.m.
CALIFORNIA ENERGY COMMISSION
1516 Ninth Street
First Floor, Hearing Room A
Sacramento, California
(Wheelchair Accessible)

Remote Attendance and Availability of Documents

Internet Webcast - Presentations and audio from the meeting will be broadcast via our WebEx web meeting service. For details on how to participate via WebEx, please see the "Remote Attendance" section toward the end of this notice.

Documents and presentations for this meeting will be available online at:

http://www.energy.ca.gov/2011_energypolicy/documents/index.html.

Purpose

The purpose of this staff workshop is to highlight how energy storage and automated demand response technologies can support renewable energy integration in California. The workshop will provide an interactive overview of the challenges of developing and deploying these technologies to support renewable integration while managing the California grid with 33 percent renewable energy by 2020.

This workshop will:

1) highlight California's energy storage, demand response, and renewable generation and integration policy goals;
2) explain the electric power system and the issues in using renewable generation and its integration;
3) explain how energy storage and Auto-DR technologies can support renewable integration;
4) highlight the activities of research projects in energy storage, Demand Response, and renewable generation and integration;
5) explain how the current and future projects provide benefits to California
6) give attendees the opportunity to ask questions and provide comments and feedback in a collaborative cordial setting.

Overall, this staff workshop will provide the Energy Commission and the public an opportunity to explore and consider a range of perspectives on energy storage and Auto-DR technologies to support renewable integration in California.

Staff seeks comments, questions, and suggestions on the presentations and other discussion documents relating to energy storage and Auto-DR technologies posted at http://www.energy.ca.gov/2011_energypolicy/documents/index.html.

Background

Since the inception of the Energy Commission's Public Interest Energy Research (PIER) program in 1997, continuously changing electricity markets, regulations, technologies, and customer behavior have raised new challenges for power generation and transmission and distribution planners, owners, operators, policy makers, and regulators. To meet these challenges, the Energy Commission performs research and development to provide new technologies in electric storage, demand response, and transmission technologies to support integration of and accommodate growing renewable electric generators such as wind and solar and new kinds of customer loads, such as electric vehicles. Expanding and modernizing our electric grid into a renewable Smart Grid for the 21st century will depend on new technology innovations in energy storage and auto-demand response technologies.

On September 29, 2010, Governor Schwarzenegger approved Assembly Bill 2514, which requires the California Public Utilities Commission (CPUC) to determine appropriate targets, if any, for each load-serving private entity to procure viable and cost-effective energy storage systems. The bill requires the California Energy Commission to review and approve the public utilities' plans to determine appropriate targets and procure viable and cost-effective energy storage systems to meet the targets. Also, the bill recognizes that despite the many benefits of energy storage, there are significant barriers to obtaining those benefits.

Energy Storage and Auto-DR technologies are expected to play a larger role in generation resource management, integration of variable resources, and peak management applications in the near future. Now is the right time for the public and regulators to explore the possible value energy storage and Auto-DR technologies can have in helping address renewables integration and shifting to lower greenhouse-gas-emitting resources.

Written Comments

Written comments on the meeting topics must be submitted by 5:00 p.m. on November 30, 2010. Please include the docket number 11-IEP-1N and indicate Technologies for Renewable Integration in the subject line or first paragraph of your comments. Please hand deliver or mail an **original copy** to:

California Energy Commission
Dockets Office, MS-4
Re: Docket No. 11-IEP-1N
1516 Ninth Street
Sacramento, CA 95814-5512

The Energy Commission encourages comments by e-mail. Please include your name or organization's in the name of the file. Those submitting attached comments by electronic mail should provide them in either Microsoft Word format or as a Portable Document (PDF) to [docket@energy.state.ca.us]. **One paper copy** must also be sent to the Energy Commission's Docket Unit.

Participants may also provide an original and 10 copies at the beginning of the workshop. All written materials relating to this workshop will be filed with the Dockets Unit and become part of the public record in this proceeding.

Public Participation

The Energy Commission's Public Adviser's Office provides the public assistance in participating in Energy Commission activities. If you want information on how to participate in this forum, please contact the Public Adviser's Office at (916) 654-4489 or toll free at (800) 822-6228, by FAX at (916) 654-4493, or by e-mail at PublicAdviser@energy.state.ca.us. If you have a disability and require assistance to participate, please contact Lou Quiroz at (916) 654-5146 at least five days in advance.

Please direct all news media inquiries to the Media and Public Communications Office at (916) 654-4989, or by e-mail at [mediaoffice@energy.state.ca.us].

If you have questions on the technical subject matter of this meeting, please call Avtar Bining, Program Manager (Energy Storage) at (916) 327-1411, or by e-mail at [abining@energy.state.ca.us].

Remote Attendance

You can participate in this meeting through WebEx, the Energy Commission's online meeting service. Presentations will appear on your computer screen, and you listen to the audio via your telephone. Please be aware that the meeting's WebEx audio and on-screen activity may be recorded.

Computer Log-on with Telephone Audio:

1. Please go to https://energy.webex.com and enter the unique meeting number: **928 233 855**

2. When prompted, enter your name other information as directed and the meeting password: **meeting@9am**

3. After you log-in, a prompt will ask for your phone number. If you wish to have WebEx call you back, enter your phone number. This will put add your name on the WebEx log so that we know who is connected and have a record of your participating by WebEx.

   If you do not wish to do that, click cancel, and go to step 4. Or, if your company uses an older switchboard-type of phone system where your line is an extension, click cancel and go to step 4.

4. If you didn't want WebEx to call you back, then call 1-866-469-3239 (toll-free in the U.S. and Canada). When prompted, enter the meeting number above and your unique Attendee ID number, which is listed in the top left area of your screen after you login via computer. International callers can dial in using the "Show all global call-in numbers" link (also in the top left area).

Telephone Only (No Computer Access):

1. Call 1-866-469-3239 (toll-free in the U.S. and Canada) and when prompted enter the unique meeting number above. International callers can select their number from https://energy.webex.com/energy/globalcallin.php

If you have difficulty joining the meeting, please call the WebEx Technical Support number at 1-866-229-3239.

Date: November 5, 2010

Mail Lists: renewable, reti, electricity, energy policy, distgen, load management, transmission, research, energy storage, demand response

2011 Integrated Energy Policy Report Staff Workshop

Technologies to Support Renewable Integration

(Energy Storage and Automated Demand Response)

CALIFORNIA ENERGY COMMISSION

1516 NINTH STREET, HEARING ROOM A

SACRAMENTO, CALIFORNIA

TUESDAY, NOVEMBER 16, 2010, 9:00 A.M. – 4:00 P.M.

Briefing Summary

On November 16, 2010, Energy Commission staff conducted a 2011 Integrated Energy Policy Report (IEPR) staff workshop to share information and solicit comments on technologies to support renewable energy integration, such as energy storage and automated demand response (AutoDR).

The purpose of this staff workshop was to:

1. Highlight how energy storage and AutoDR technologies can support renewable energy integration.
2. Explain the electric power system and the issues in using renewables and their integration.
3. Explore and consider various perspectives on energy storage and AutoDR technologies to support renewable integration.

The Workshop was attended (70 in person and over 150 on WebEx) by representatives of utilities (PG&E, SCE, SDG&E, SMUD, ...), technology developers and providers, national laboratories, universities, Federal Energy Regulatory Commission, California Energy Storage Alliance, and several state agencies (Air Resources Board, California Public Utilities Commission (CPUC), California Independent System Operator (CAISO). A brief summary of the day's presentations is provided later in this memo. One noteworthy WebEx presentation came from the CPUC staff when they discussed the CPUC's plans to implement the 2010 Energy Storage Bill, AB 2514 and answered questions from the participants.

Workshop Observations:

1. The workshop discussed all the major energy storage technology demonstrations currently planned in California and reviewed the status of energy storage technologies nationwide.

2. This was the first workshop where energy storage and AutoDR were discussed as complimentary technologies. The concept of using AutoDR to support renewable integration was first initiated at the Energy Commission based on over six years of successful research with commercial and industrial customers completed by the Demand Response Research Center (DRRC) for the Public Interest Energy Research (PIER) program. For this workshop, the DRRC led a discussion on how AutoDR could be used in the CAISO ancillary market. The high interest in AutoDR is due to the expected cost per megawatt for AutoDR support, estimated be as low as ten percent of the cost of comparable energy storage technology. However, AutoDR cannot currently provide 24 hour a day service like energy storage. The DRRC is currently completing research to understand the use of AutoDR on a 24 hour envelop.

3. Most workshop participants agreed that energy storage and AutoDR technologies and products can have an important role to integrate renewables and achieve the 33 percent Renewable Portfolio Standard (RPS) goal by 2020.

4. Workshop participants agreed that a better understanding of current status, costs, and benefits of energy storage and AutoDR systems and products is needed for their wide scale deployment as cost-effective and commercially available options.

5. Successful deployment of energy storage technology and products will also depend on market rules and policy recognition of energy storage. Addressing these challenges will help enable deployment of energy storage technologies to support integration of renewables.

6. During the discussion, Mike Gravely reviewed a planned PIER research effort to develop a 2020 Energy Storage Vision for California by working interactively with utilities, energy storage industry, and other stakeholders. This research effort is scheduled to be voted on by the Energy Commission at a Business Meeting in late December or early January. The results of this six month project will be provided to CPUC and others to support their efforts for implementing the AB 2514 requirements.

7. There were discussion throughout the day on the current state of energy storage technologies and what barriers exist that prevents the expansion of energy storage technologies in California.

8. The meeting adjourned at 4:00 PM.

9. There were 16 presentations given at the workshop. A brief summary of each presentation is included in Attachment 1.

Next Steps:

1. This workshop was focused on technology. There will be a workshop planned for the March-April 2011 timeframe to discuss policy recommendations and issues that need to be addressed.

2. The Energy Commission PIER Program will initiate a contract to develop a 2020 Energy Storage Vision for California. This contract will involve at least one public workshop. Attendees to the first public workshop will be invited to future public workshops held in connection with the development of the vision.

3. The CPUC will host a public workshop for the Smart Grid Deployment Plan Bill, SB 17 in the March-April 2011 time frame.

Attachment 1

2011 Integrated Energy Policy Report Staff Workshop

Technologies to Support Renewable Integration

(Energy Storage and Automated Demand Response)

CALIFORNIA ENERGY COMMISSION

1516 NINTH STREET, HEARING ROOM A

SACRAMENTO, CALIFORNIA

TUESDAY, NOVEMBER 16, 2010, 9:00 A.M. – 4:00 P.M.

Summary of Workshop Presentations

1. Introduction and Opening Comments, Laurie ten Hope, California Energy Commission

Laurie ten Hope, Deputy Director for the Research and Development Division at the Energy Commission talked about the importance and role energy storage and AutoDR can play in integrating renewables into the distribution and transmission grid to achieve California's renewable goal of 33 percent by 2020. Laurie also mentioned that AB 2514, the Skinner Bill, requires the CPUC to look at regulatory strategies to incorporate energy storage. This workshop and other work in the PIER program will hopefully assist the CPUC in its responsibilities under AB 2514.

2. Workshop Overview - Energy Storage and Automated Demand Response (Auto-DR), Mike Gravely, California Energy Commission

Mike Gravely from the Energy Commission explained the purpose of the workshop and PIER plans in supporting the IEPR over the next year in the energy storage area. As part of the 2011 IEPR process, this workshop will be helpful in 1) putting together a current state assessment of fielding utility scale energy storage and AutoDR to support renewable integration, and 2) what needs to be done in the next year to support the 2011 IEPR recommendations on energy storage and AutoDR. Mike further explained that a substantial number of energy storage and AutoDR projects funded through the American Recovery and Reinvestment Act will accelerate the commercialization of some of these technologies. Finally, the workshop will discuss the value of integrating AutoDR as a grid service similar to energy storage, as opposed to demand response as only a peak load reduction service, and will help determine barriers and obstacles, and challenges and opportunities. Another workshop is expected in the March-April 2011 timeframe to follow on the information gained at this workshop.

3. **Managing the California Grid and Integrating 33% Renewables, Udi Helman, California Independent System Operator (CAISO)**

Udi Helman from the CAISO provided an overview of CAISO efforts and initiatives addressing renewable integration and implications for storage and demand response. The CAISO last year implemented a new market design in which market price signals are much more heavily a function of constraints on the system than they were in the past. The new market design is a day ahead, hourly market and a real time five-minute dispatch market, all of which prices are calculated on the basis of a full network model that includes unit operational and transmission constraints. This new system is better suited for the integration of renewable, demand response and energy storage technologies. CAISO envisions that market prices will be a major piece of the control of both automated and dispatchable resources in the future, and will allow for a better understanding of the impact of both storage and demand response on grid planning.

4. **Energy Storage - CPUC Perspective, Chris Villarreal, California Public Utilities Commission (CPUC)**

Chris Villarreal from the CPUC presented the CPUC view point on energy storage. The CPUC has a very strong interest in supporting energy storage as it is a critical technology to help meet the 20 percent and future 33 percent goal of intermittent and renewable resources. Along with other scenarios, such as shutting down the once-through cooling facilities and increasing loads through electric vehicles (EVs), storage is going to have an even greater role, not only on the transmission side, but also on the distribution side. The challenge for the CPUC is to adequately account for the various revenue streams involving storage and its applications. AB 2514 directs the CPUC to open a proceeding by 2012, to address strategies and policies regarding storage to establish storage targets and the cost-effectiveness of storage projects. Chris also described a couple of energy storage projects. The CPUC expects to create policies in the near future to create a market for storage that is appropriate for increased renewable, EVs, and distributed side generation and storage.

5. **Results of PIER Research: Research Evaluation of Wind Generation, Solar Generation, and Storage Impact on the California Grid, Dave Hawkins, KEMA, Inc.**

Dave Hawkins from KEMA, Inc. presented results of a PIER funded project completed in 2009 to look at the integration of energy storage as California increases renewable generation. The main objective of this project was to look at very short time interval variability, the role of energy storage, the amount of storage needed, and its impact on the ancillary services regulation, as well as storage versus a real fast gas turbine. The results showed that energy storage can play a significant role under different scenarios of renewable integration in California. This study was the first to identify the potential need for thousands of megawatts of additional ancillary services (energy storage or fast generation) to support the operation of the grid in 2020 with 33 percent renewable energy. This study can be further enhanced in the future by including AutoDR and transmission constraints. The CAISO and PIER are looking into how to complete this analysis.

6. SCE's Approach to Energy Storage, John Minnicucci, Southern California Edison (SCE)

John Minnicucci from SCE talked about SCE's strategy for storage and its activities, and described a few energy storage demonstration projects. SEC has a long history with energy storage and approaches it from the technology standpoint and from the strategic standpoint. SCE also approaches energy storage from the perspective of system needs and applications. The challenge is to determine the best technologies and their practical cost-effective uses. SCE has a number of ongoing efforts with Department of Energy (DOE) and Energy Commission projects. These projects will help better understand about valuing energy storage and identify the best technology and the applications.

7. The Use of Large Scale Pumped Hydro Energy Storage for Renewable Integration and Renewable Load Shifting, Doug Divine, Eagle Crest Energy

Doug Divine, CEO of Eagle Crest Energy, a pump storage developer, along with two of his colleagues from the National Hydro Association, Don Erpenbeck from MWH and Rick Miller from HDRDTA, talked about some of the issues on advanced pumped hydro storage to assist with renewable integration, grid reliability, and renewable load shifting. Pump storage is one of several technologies that can partner with variable energy resources. Currently pump storage is the only commercially proven large scale energy storage technology from 40 megawatts to over 2,000 megawatts. Don Erpenbeck talked about some of the advanced technologies (adjustable speed machines) and the benefits they will bring to the system. Many pumped hydro projects are currently operating or planned in the United States, California and several European countries (Spain, Switzerland, Portugal, etc.) for integrating wind generation. Rick Miller discussed various aspects of storage in Europe, particularly in Spain. Doug Divine discussed that California has a rich history of pump storage with projects like Helms and Castaic, and that there are currently eight projects permitted and about 6,000 megawatts under development in California. There are markets in California for pump storage, but due to the large capital costs of these projects, it will need long term buyers and storage tax credits and incentives for developing storage projects. Under AB 2514, pumped storage industry looks forward to working with both the Energy Commission and the CPUC on these issues.

8. **Integrating Large Scale Distributed Energy Resources to Provide the Grid Megawatts of Energy, Frank Ramirez, ICE Energy**

Frank Ramirez from ICE Energy talked about a distributed project that takes numerous sources of distributed energy and controls them as one large project. The project is attempting to answer how numerous distributed energy resources can be turned into a single controlled grid resource (like a virtual power plant)? The ICE Energy technology is an electro-thermal technology and has high efficiency for leveraging available energy resources during off-peak periods. It can offset the need for air-conditioning comfort when needed for up to 6 hours providing benefits similar to that provided by electrical storage resources. ICE Energy presented that its technology is proven, is cost-effective, Smart Grid enabled, ready for large scale deployment, commercially available, and capable of creating hundreds of jobs in California. It has accumulated more than five million hours of field operation piloted by 24 utilities over a seven-year period. ICE Energy has already deployed approximately 200 units, and expects to eventually deploy as many as 6,000 units at customer sites. ICE Energy also presented that a 100 megawatt ICE Energy project generates approximately 300 direct jobs, paying hourly wages of over $60 million associated with the units building, and their installation and commissioning. ICE Energy requested that distributed energy storage be included by the Energy Commission in the IEPR and other relevant policy proceedings as a valuable utility scale, cost-effective, renewables integrating, and commercially available resource.

9. **Importance of Energy Storage to California's Renewable Future, Janice Lin, California Energy Storage Alliance (CESA)**

Janice Lin from the California Energy Storage Alliance (CESA) (established in 2009 and with 28 members), was very involved in AB 2514, and represents advance energy storage throughout the country. Janice talked about the importance of energy storage to California's renewable future. CESA's mission as an organization is to expand the role of storage technology to accelerate the adoption of renewables in a clean, more affordable, and reliable electric power system in California. CESA is technology neutral, represents about every storage technology and supports all ownership models, and its focus is California. CESA feels that government intervention is needed to align the benefits with the cost as means to remove some of the barriers to diverse applications of energy storage. CESA fully supports results of CAISO, KEMA and E3 studies estimating if sufficient energy storage is installed by 2020, there is no need to curtail valuable clean renewable energy. CESA believes that energy storage is fundamental to many energy policy initiatives in California. Janice listed for some specific ideas for how the Energy Commission can accelerate progress to that goal.

10. Applying Large Scale Lithium-Ion Energy Storage Technology to Supporting Renewable Integration and Grid Services, Charlie Vartanian, A123 Systems

Charlie Vartanian from A123 Systems emphasized that 1) in energy storage within the last ten years, there have been significant technical and commercial breakthroughs, making the technology relevant to applications; 2) as an asset class, storage has a diversity of capabilities from very fast to very long, and 3) regulatory evolution is a number one need for energy storage to advance. A123 Systems builds lithium-ion batteries and battery-based systems using cathode chemistry for packaging various size systems, from small to large scale (as big as 200 megawatts). A123 Systems' Grid scale systems are built in Hopkin, Massachusetts, creating clean energy jobs in the United States.

11. Applying Large Scale Energy Storage to Support Grid Operations (Sodium Sulfur Battery Technology and Compressed Air Energy Storage), Robert Schainker, Electric Power Research Institute (EPRI)

Robert Schainker from EPRI talked about a couple of PG&E and CPUC projects that EPRI is actively involved with. The projects discussed were the compressed air energy storage (CAES) project and the largest sodium-sulfur battery storage system in California. Robert mentioned that the renewable mix for PG&E, between 2005 and 2020, is going to experience a very large growth in solar and wind. Energy storage can accommodate the power fluctuations from both solar and wind and need to be demonstrated in a real world environment, not a simulated environment, on a real utility in California, such as PG&E. Pumped hydro, compressed air, and sodium- sulfur battery are three commercially available energy storage technologies particularly useful for bulk or large storage providing support to CAISO grid operations. The sodium-sulfur battery system is four megawatt and seven hour storage capacity at Hitachi Plant Substation in San Jose, CA and will be operational in 2011. The compressed air energy storage project is a 300 MW and 10 hour storage system and will be installed near wind resources and is expected to be fully operational in 2017.

12. How to integrate Energy Storage and Demand Response into the Wide Area Network Control of the Electric Grid, Jeff Dagle, Pacific Northwest National Laboratory

Jeff Dagle from Pacific Northwest National Laboratory (PNNL) discussed two specific technology examples: 1) Wide-Area Energy Management Storage (WAMES) concept, and 2) Dynamic Load Control to stabilize the transmission network. The WAMES concept involved a flywheel energy storage system integrated with hydro renewable generation and simulated the performance, the value and the benefits. Through a properly designed WAEMS control algorithm, it demonstrated that this concept has the potential to provide cost competitive frequency regulation service while reducing wear and tear on the hydro units. The Dynamic Load Control Scheme to Stabilize the Transmission Network project looked at the concept of a fast acting dynamic load control to stabilize the electric power grid. It explored various locational aspects and control algorithms to provide the right kind of energy, both real and reactive power. It showed that additional gain is experienced when the total modulation is dispersed amongst the distributed load, as opposed to just doing it at one location.

13. **Integration of Energy Storage and Automated DR onto the SMUD Gird Network, Jim Parks, Sacramento Municipal Utility District (SMUD)**

Jim Parks from SMUD talked about various drivers as well as issues for integration of energy storage and AutoDR onto the SMUD grid network such as greenhouse gas regulations, the RPS goal of 33 percent renewables by 2020, and summer peak load as high as 400 megawatts for just 40 hours out of the year. SMUD believes energy storage and demand response are ways to overcome some of those issues. Both solar and wind will play a major role in reducing greenhouse gas emissions. SMUD is looking at both bulk and distributed energy storage and trying to determine the cost, value and benefits of energy storage. Jim presented several ongoing energy storage projects underway at SMUD (in collaboration with DOE and the Energy Commission).

14. **AutoDR and Renewable Integration, Mary Ann Piette, Lawrence Berkeley National Laboratory**

Mary Ann Piette, Director of the Demand Response Research Center at Lawrence Berkeley National Laboratory talked about AutoDR, Open AutoDR and AutoDR as a Grid resource. Open AutoDR is basically non-proprietary specifications for communications to build Auto DR using application programming interface available in the public domain. Highlighting that the California RPS is increasing to 33 percent in 2020, the Grid will require over four gigawatts of ancillary service to maintain grid stability. AutoDR has lower first cost, operating cost and carbon footprint and leverages multi-purpose systems for energy efficiency. Though AutoDR research and commercialized deployments have successfully proven multi-year performance capabilities during peak periods and have a fast response, challenges still exist for AutoDR as a 24 hour-a-day ancillary service. AutoDR could currently provide 250 megawatts to 800 megawatts with a shed potential between 400 megawatts to 1,800 megawatts with additional investments. Economic evaluation, additional off-peak data from field tests and surveys, and geographic considerations are some of the future research areas for AutoDR.

15. **Auto-DR for Ancillary Services and Integration of Intermittent Renewable Resources: PG&E Pilots, Albert Chiu, PG&E**

Albert Chiu from Pacific Gas and Electric (PG&E) discussed PG&E's Auto-DR goals, engaging more customers into the Auto-DR technology, and using Auto-DR technology to integrate with emerging technologies, such as energy storage including permanent load shifting technologies for the utility demand side management. There is an opportunity to use Auto-DR and or energy storage together to help integrate intermittent resources. One important objective of PG&E pilots in this area is to position Auto-DR technology and open protocols to enable demand side to provide resources compatible with the CAISO products. Working with CAISO, PG&E is looking at if coupling Auto-DR with embedded or thermal energy storage can provide regulation and five minute real time energy services to the CAISO; integration with CAISO's Automatic Generator Control with Auto-DR's Demand Response Automated Server; and the optimization of thermal energy storage and other options that can mitigate intermittency.

16. **Integrating Demand Response, Intermittent Renewables and Wholesale Electric Markets, Jeremy Laundergan, Southern California Edison (SCE)**

Jeremy Laundergan from Southern California Edison (SCE) presented SCE's perspective on demand response and wholesale market triggers in response to intermittent renewable. Working with CAISO, SCE is using Open AutoDR through internet for large commercial and industrial customers. Also, SCE plans to use ZigBee Smart Energy Profile 2.0 enabled through Edison SmartConnect for residential and small/medium commercial and industrial customers. However, there are many big challenges to demand response for it to actually be playing in ancillary services, such as high cost of telemetry and real time interval settlement requirement. SCE is working closely with CAISO to figure out various alternatives. For residential customers air-conditioning cycling, SCE has done a lot of testing, and currently has 350,000 customers with 450,000 devices, providing 750 megawatts of response. SCE, over the last two years, has been examining how this resource can make itself available in the ancillary services market to address, in part, intermittent renewables.

Docket Written Comments Summary

1. SCE stated that energy storage may improve the integration of renewables to the grid; however, a better understanding of the specific operating attributes of AutoDR and energy storage technologies most valuable for renewable integration is needed. SCE believes that the market will direct load serving entities toward the most useful and cost-effective renewable integration technologies and the Energy Commission should avoid recommending the use of technology mandates and should instead allow the market to drive the technology selection process.

2. PG&E recognizes that electricity system needs energy storage and AutoDR as means to improve grid performance, renewables integration, and as ancillary services. PG&E supports more efforts and research funds to further determine the value, costs and benefits as well as current status of these technologies, and to develop appropriate market rules and policy facilitating their deployment.

3. Hydrogen Technology, Inc. described its thermal hydrogen process and requested it to be included for discussion and consideration of the technologies able to support renewable energy integration such as energy storage and AutoDR technologies in the 2011 IEPR relating to energy systems and renewables in California.

California Energy Commission
IEPR Staff Workshop

Technologies to Support Renewable Integration (Energy Storage and Automated Demand Response)

November 16, 2010 – 9:00 a.m.

Hearing Room A

AGENDA

9:00-9:10	**Introduction and Opening Comments** Laurie ten Hope, California Energy Commission
9:10-9:40	**Workshop Overview - Energy Storage and Automated Demand Response (Auto-DR)** Mike Gravely, California Energy Commission
9:40-10:00	**Managing the California Grid and Integrating 33% Renewables** Udi Helman, California Independent System Operator
10:00 -10:45	**Results of PIER Research: Research Evaluation of Wind Generation, Solar Generation, and Storage Impact on the California Grid** Dave Hawkins, KEMA, Inc.
10:45-11:00	**SCE's Approach to Energy Storage** John Minnicucci, Southern California Edison
11:00-11:20	**The Use of Large Scale Pumped Hydro Energy Storage for Renewable Integration and Renewable Load Shifting** Doug Divine, Eagle Crest Energy
11:20-11:40	**Integrating Large Scale Distributed Energy Resources to Provide the Grid Megawatts of Energy** Frank Ramirez, ICE Energy
11:40-11:55	**Importance of Energy Storage to California's Renewable Future** Janice Lin, California Energy Storage Alliance
11:55-12:10	**Applying Large Scale Li-Ion Energy Storage Technology to Supporting Renewable Integration and Grid Services** Charlie Vartanian, A123 Systems
12:10-1:15	**Lunch**

1:15-1:45	**Applying Large Scale Energy Storage to Support Grid Operations (Sodium Sulfur Battery Technology and Compressed Air Energy Storage)** Robert Schainker, Electric Power Research Institute
1:45-2:00	**How to integrate Energy Storage and Demand Response into the Wide Area Network Control of the Electric Grid** Jeff Dagle, Pacific Northwest National Laboratory
2:00-2:15	**Integration of Energy Storage and Automated DR onto the SMUD Gird Network** Jim Parks, Sacramento Municipal Utility District
2:15-2:45	**Auto-DR and Renewable Integration** Mary Ann Piette, Lawrence Berkeley National Laboratory
2:45-3:05	**Auto-DR for Ancillary Services and Integration of Intermittent Renewable Resources: PG&E Pilots** Albert Chiu, Pacific Gas & Electric
3:05-3:20	**Demand Response Wholesale market triggers in response to intermittent renewables,** Jeremy Laundergan, Southern California Edison
3:20-4:30	**Public Comments** Mike Gravely, California Energy Commission
4:30-4:45	**Next Steps and Plans for Spring 2011 IEPR Workshop on Energy Storage and Automated DR Policy Recommendations** Mike Gravely, California Energy Commission
4:45-5:00	**Closing Remarks (IEPR Committee and CEC Staff)**
5:00	**Adjourn**

California Energy Commission

2011 IEPR Staff Workshop

Technologies to Support Renewable Integration

(Energy Storage & Automated Demand Response)

November 16, 2010

Laurie ten Hope

Deputy Director

Energy Research and Development Division

California Energy Commission

AGENDA

9:00-9:10	Introduction and Opening Comments, Laurie ten Hope, California Energy Commission
9:10-9:40	Workshop Overview - Energy Storage and Automated Demand Response (Auto-DR), Mike Gravely, California Energy Commission
9:40-10:00	Managing the California Grid and Integrating 33% Renewables, Udi Helman, California Independent System Operator
10:00 -10:45	Research Evaluation of Wind Generation, Solar Generation, and Storage Impact on the California Grid, Dave Hawkins, KEMA, Inc.
10:45-11:00	SCE's Approach to Energy Storage , John Minnicucci, Southern California Edison
11:00-11:20	Use of Large Scale Pumped Hydro Energy Storage for Renewable Integration and Renewable Load Shifting, Doug Divine, Eagle Crest
11:20-11:40	Integrating Large Scale Distributed Energy Resources to Provide the Grid Megawatts of Energy, Frank Ramirez, ICE Energy
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2:00-2:15	Integration of Energy Storage and Automated DR onto the SMUD Gird Network , Jim Parks, Sacramento Municipal Utility District
2:15-2:45	Auto-DR and Renewable Integration , Mary Ann Piette, Lawrence Berkeley National Laboratory
2:45-3:05	Auto-DR for Ancillary Services and Integration of Intermittent Renewable Resources: PG&E Pilots, Albert Chiu PG&E
3:05-3:20	Demand Response - Wholesale market triggers in response to intermittent renewables, Jeremy Laundergan, Southern California Edison
3:20-4:30	Public Comments , Mike Gravely, California Energy Commission
4:30 – 4:45	Next Steps and Plans for Spring 2011 IEPR Workshop on Energy Storage and Automated DR Policy Recommendations Mike Gravely, California Energy Commission
4:45-5:00	Closing Remarks (IEPR Committee and CEC Staff)
5:00	Adjourn

3:20-4:30 Public Comments ,

Mike Gravely,

California Energy Commission

4:30 – 4:45

Next Steps and Plans for Spring 2011 IEPR Workshop on Energy Storage and Automated DR Policy Recommendations

Mike Gravely,

California Energy Commission

4:45-5:00 Closing Remarks (IEPR Committee and CEC Staff)

Mike Gravely,

California Energy Commission

Written Comments

- Must be submitted by 5:00 p.m. on November 30, 2010.
- Please include the docket number 11-IEP-1N and indicate Technologies for Renewable Integration in the subject line or first paragraph of your comments.
- Please hand deliver or mail an original copy to:

California Energy Commission
Dockets Office, MS-4
Re: Docket No. 11-IEP-1N
1516 Ninth Street
Sacramento, CA 95814-5512

5:00 Adjourn

Contacts:

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916-704-4339

Avtar Bining abining@energy.state.ca.us

916-327-1411

California Energy Commission

Workshop Overview

Energy Storage and

Automated Demand Response (Auto-DR)

November 16, 2010

Michael Gravely
Manager
Energy Systems Research Office
California Energy Commission
mgravely@energy.state.ca.us / 916-704-4339

Workshop Purpose

- Discuss the current status of energy storage and automated demand response (DR) technologies to support integration of renewables
- Review active energy storage and automated DR projects
- Determine major obstacles and barriers to the advancement of emerging energy storage and automated DR technologies
- Establish a technology baseline for the 2011 IEPR
- Discuss activities that need to occur prior to the Spring 2011 IEPR workshop to develop recommended policies and actions to accelerate the fielding of energy storage and automated DR products

PIER Involvement in Energy Storage and Automated DR Technologies

PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

- PIER has a long history of interest in advancing energy storage technologies:
  - Funding field demonstrations and studies
  - Encouraging partnering and information exchange
  - Sharing the story
- PIER program funded initial research into the broad use of automation in DR technologies
  - Formed the Demand Response Research Center
  - Supported over eight years of research and field demonstrations
  - Supported the implementation of Open ADR protocol as part of national Smart Grid standards

PIER Program has a History of Evaluating the Full Range of Energy Storage Technologies

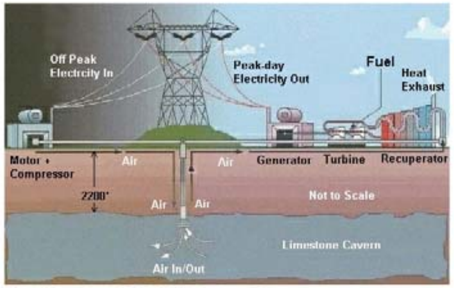


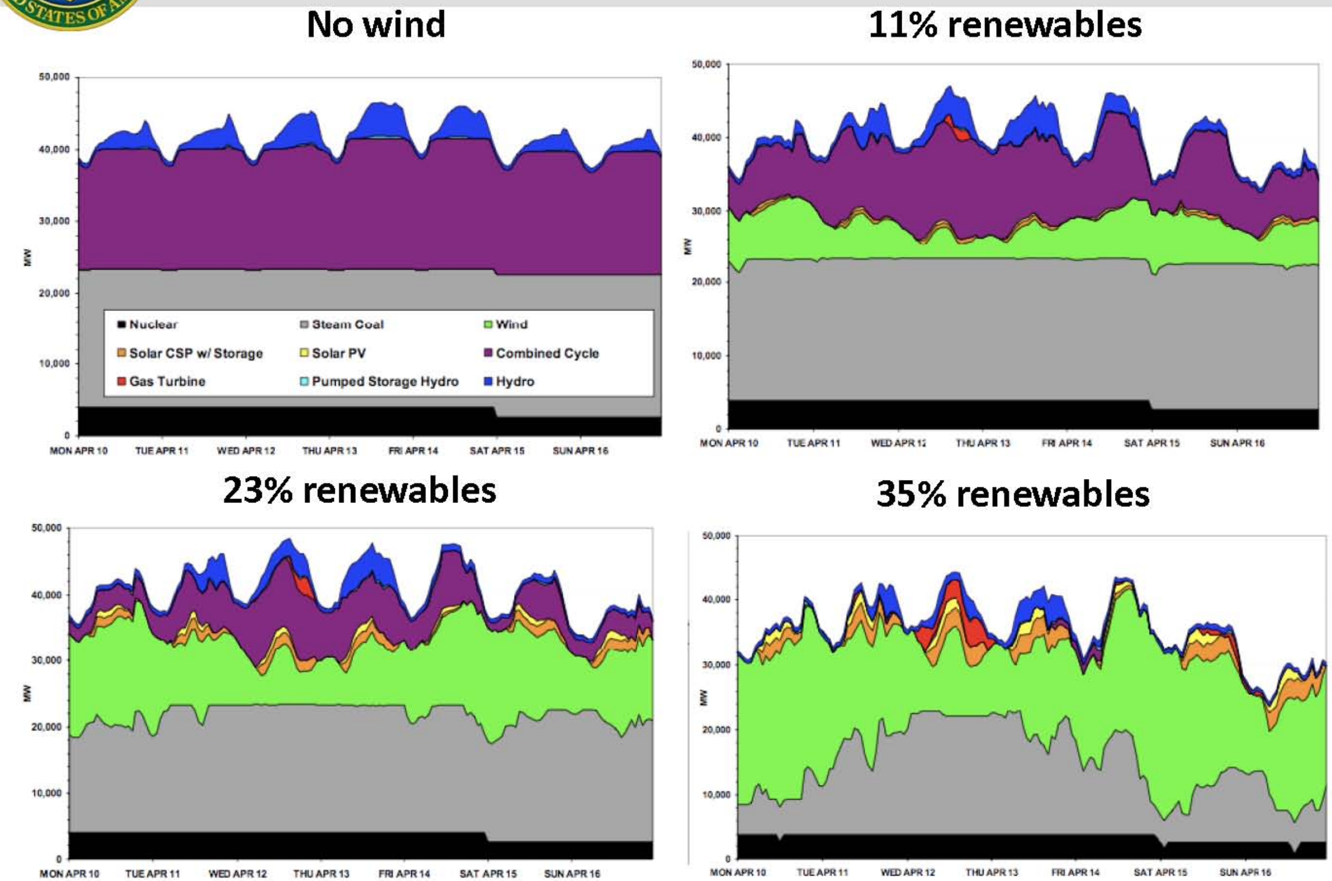
Photo Courtesy of CAES Development Company

100 kW, 15 kWh li-ion battery for UPS applications

Photo Courtesy of Saft America

Future Challenges

OE - Variable Generation Affects Grid Operations

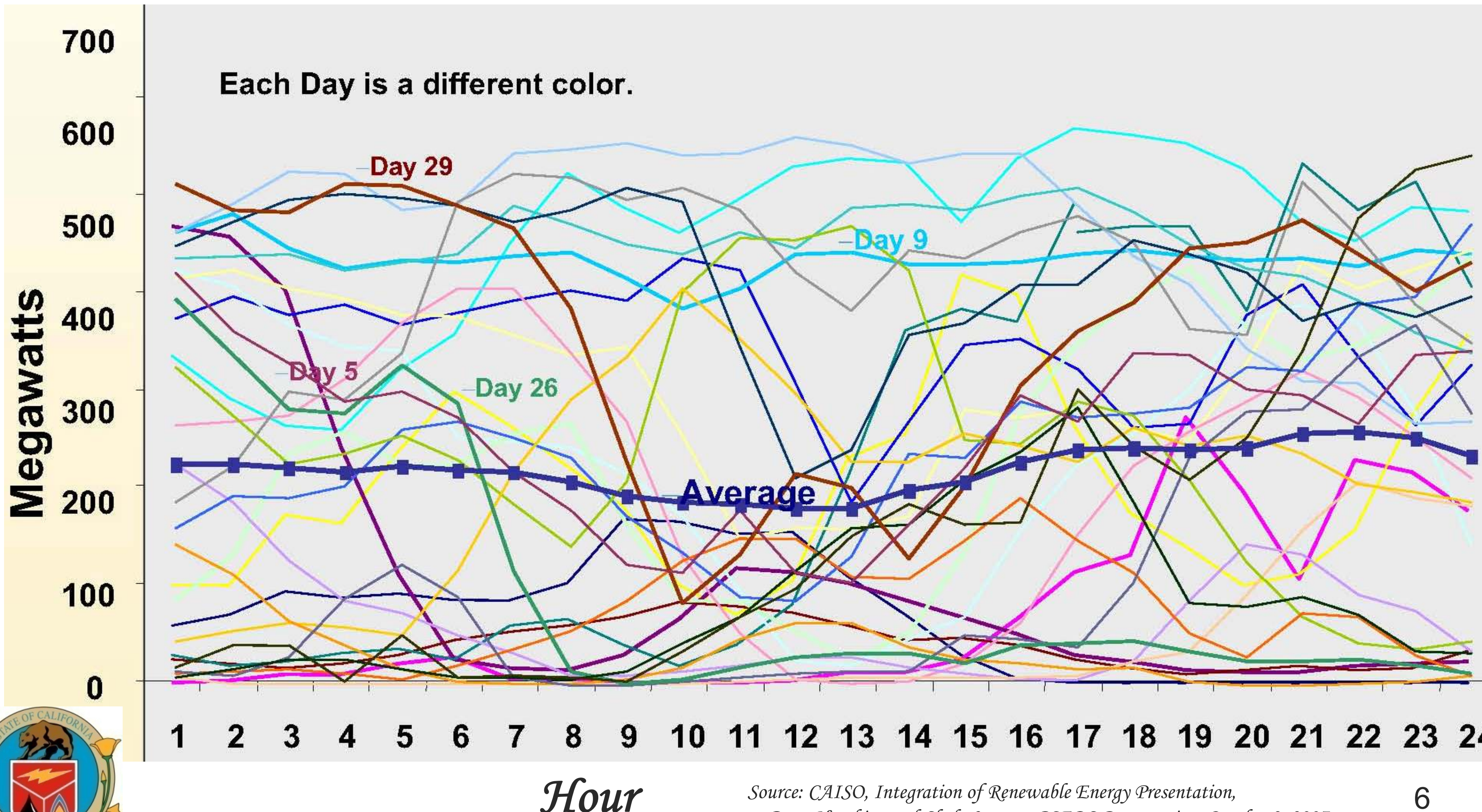


Lew et. al. "How do Wind and Solar Power Affect Grid Operations: The Western Wind and Solar Integration Study". National Renewable Energy Laboratory. (September 2009). p. 6

8

Wind Energy Production is a Challenge to Forecast

Wind Generation in Tehachapi – April 2005



Source: CAISO, Integration of Renewable Energy Presentation, Dave Hawkins and Clyde Loutan, PSERC Presentation, October 2, 2007

California ISO
Your Link to Power

2013 Solar Ramps will be an issue to manage

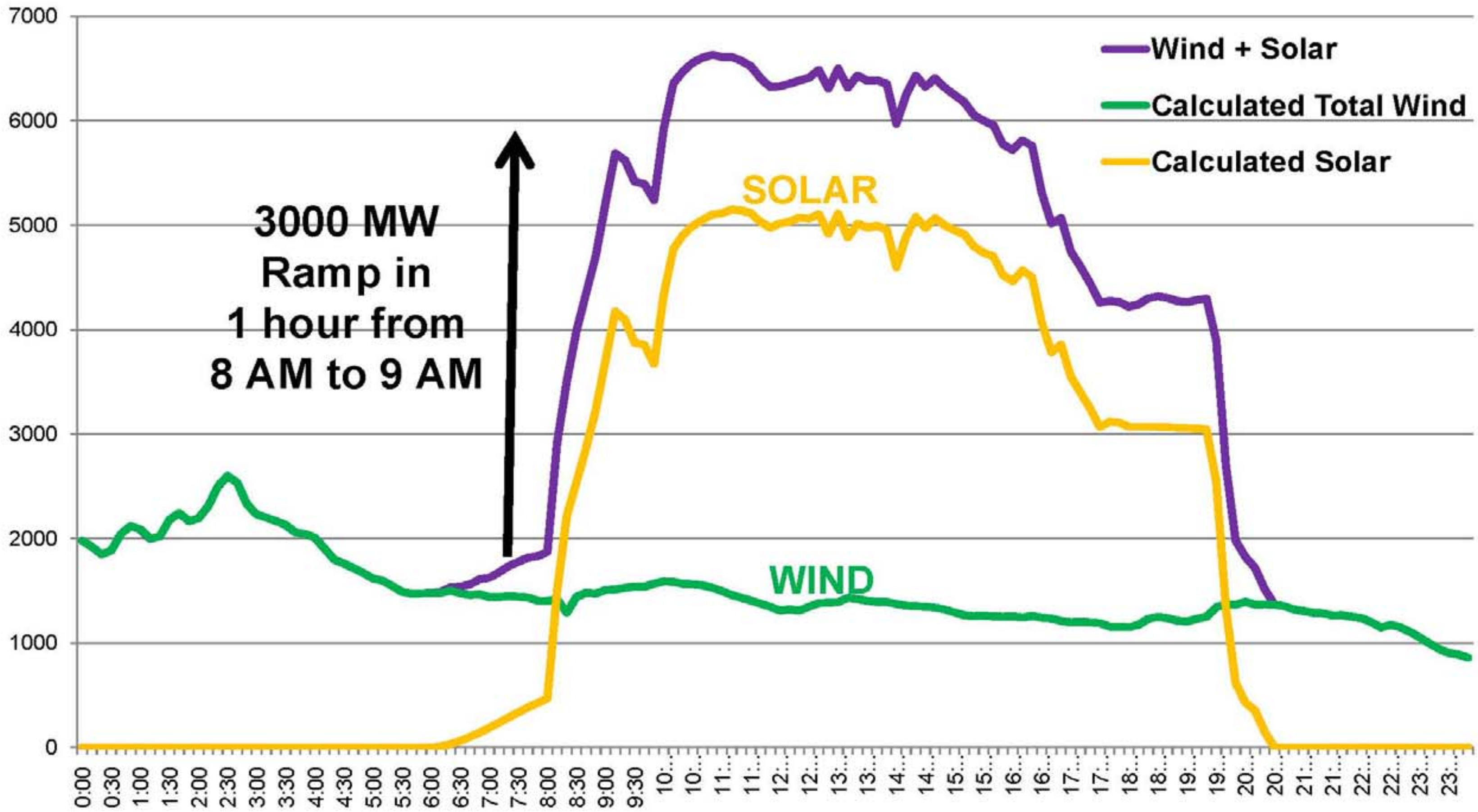


Chart based on March 2010 actual data and escalated to amount of renewables expected in 2013

Slide 9

Energy Storage Technologies

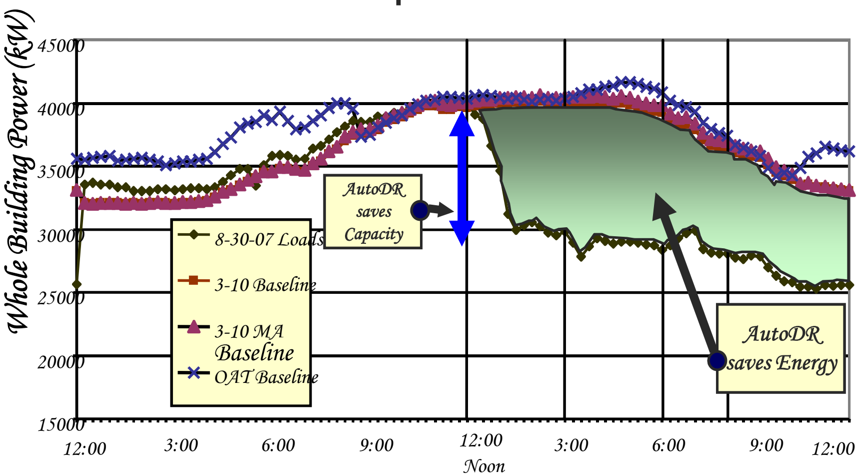
- Pumped Hydro
- Compressed Air Energy Storage (CAES)
- Flywheels
- Batteries
- Super-Capacitors (SuperCaps)
- Superconducting Magnetics
- Thermal Storage
- Fuel Cells (reversible)
- Hydrogen Storage

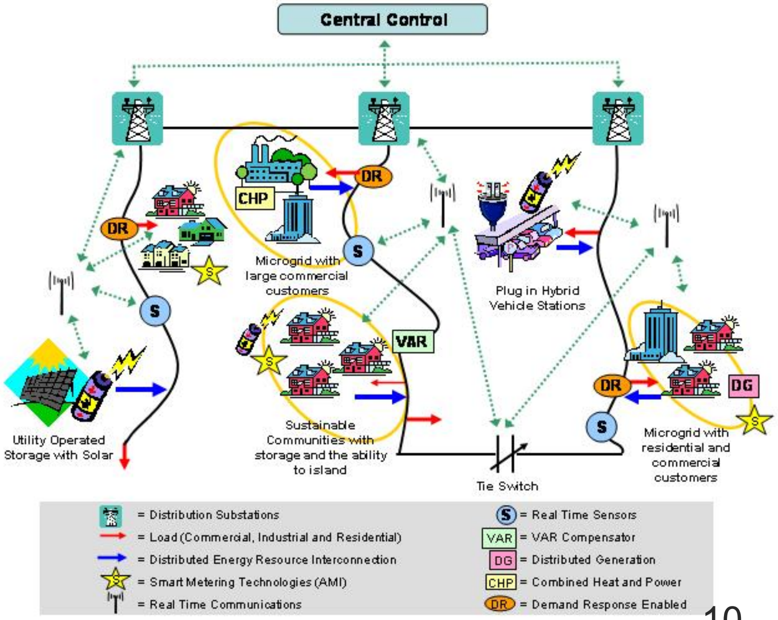
Upcoming PIER Funded Research Project

- Develop an initial California vision for energy storage for 2020
- Prime Contractor is the California Institute for Energy and the Environment (CIEE)
- 6 month effort
- Help understand the role of energy storage in California
  - Look at full range of applications
  - Help CPUC with AB 2514 implementation
  - Share results in Spring 2011 IEPR workshop

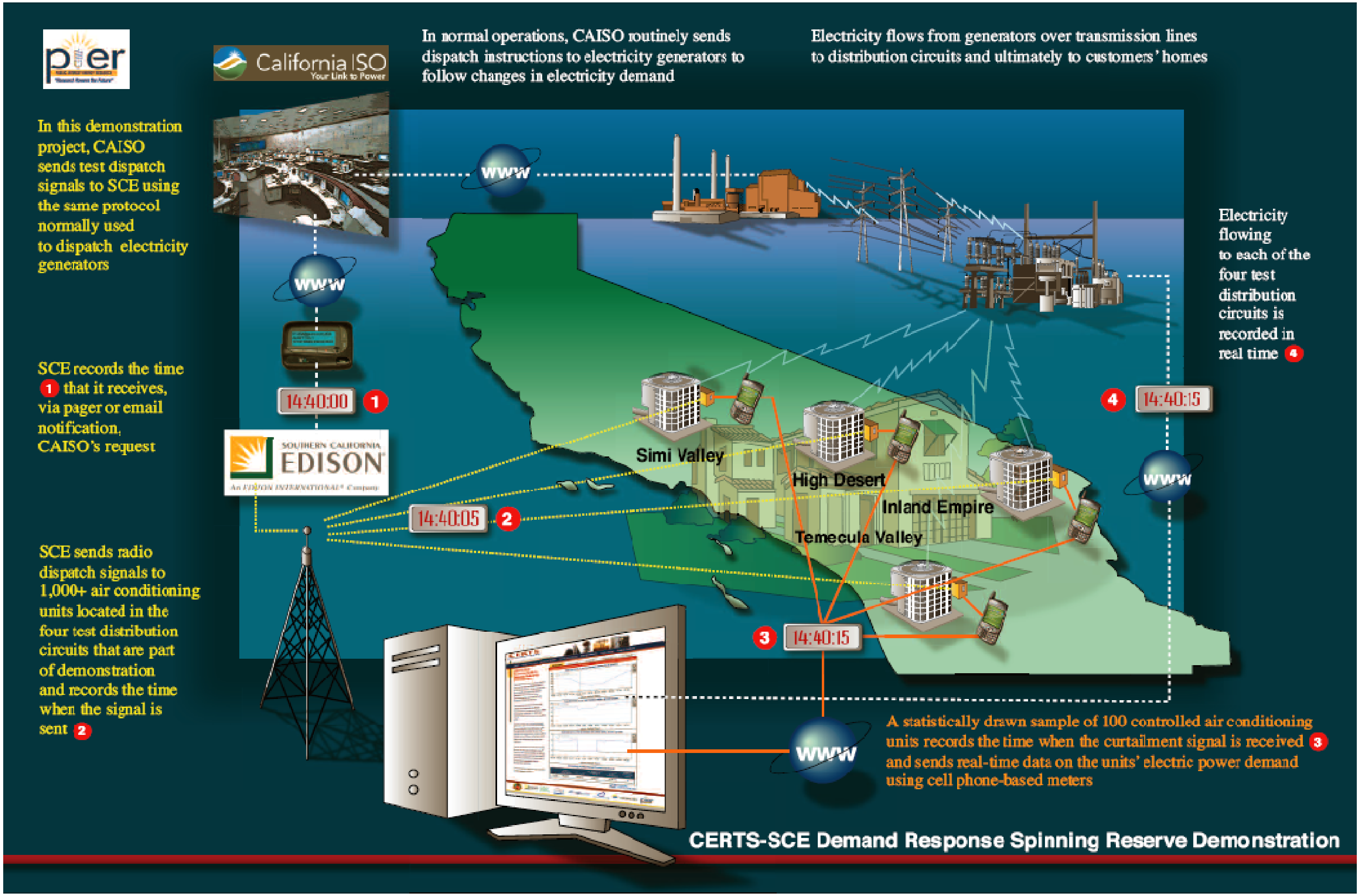
Integration of Demand Response

PG&E AutoDR Test Day – All AutoDR Participants – 8/30/07

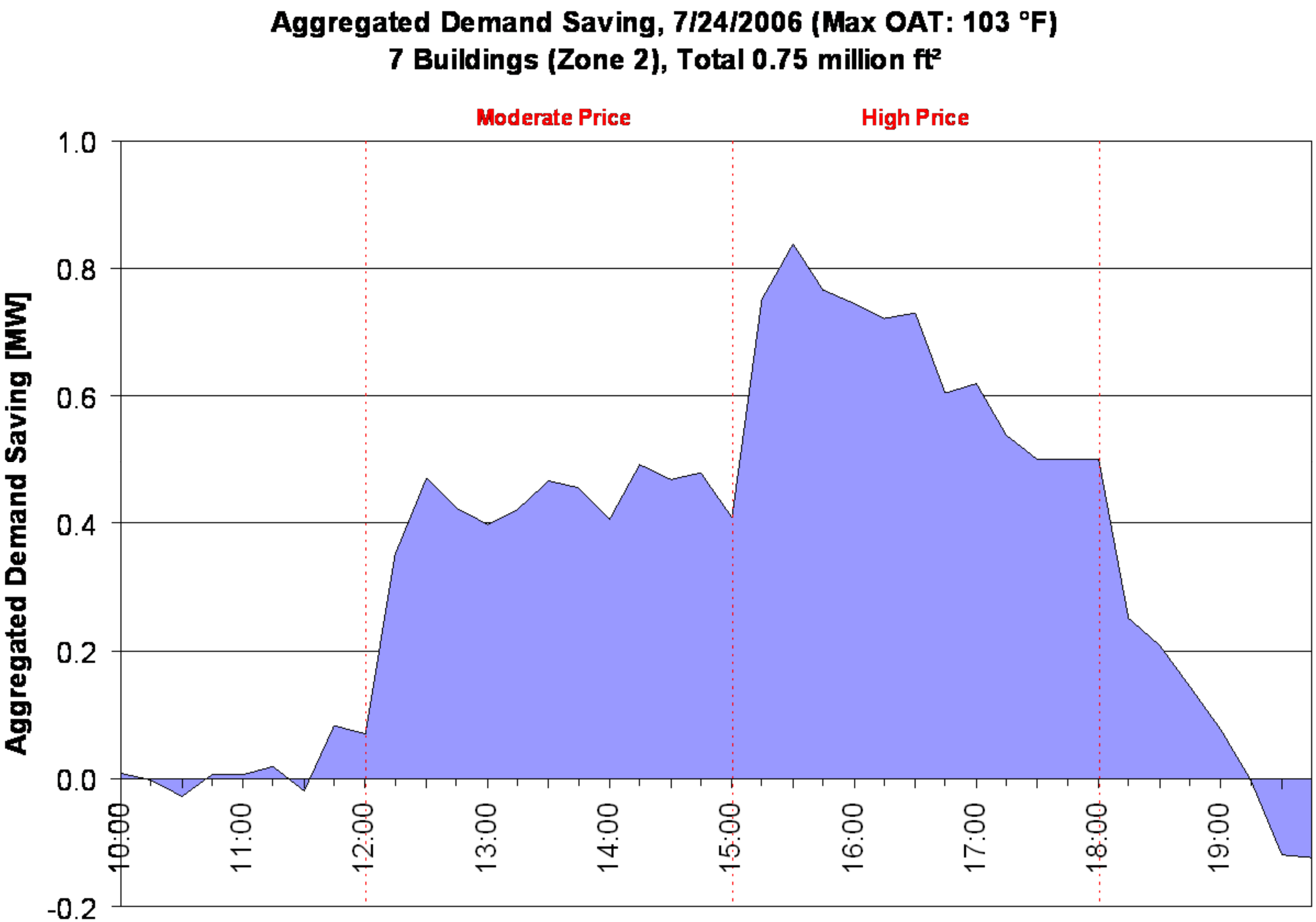




DR as Spinning Reserve or Ancillary Service

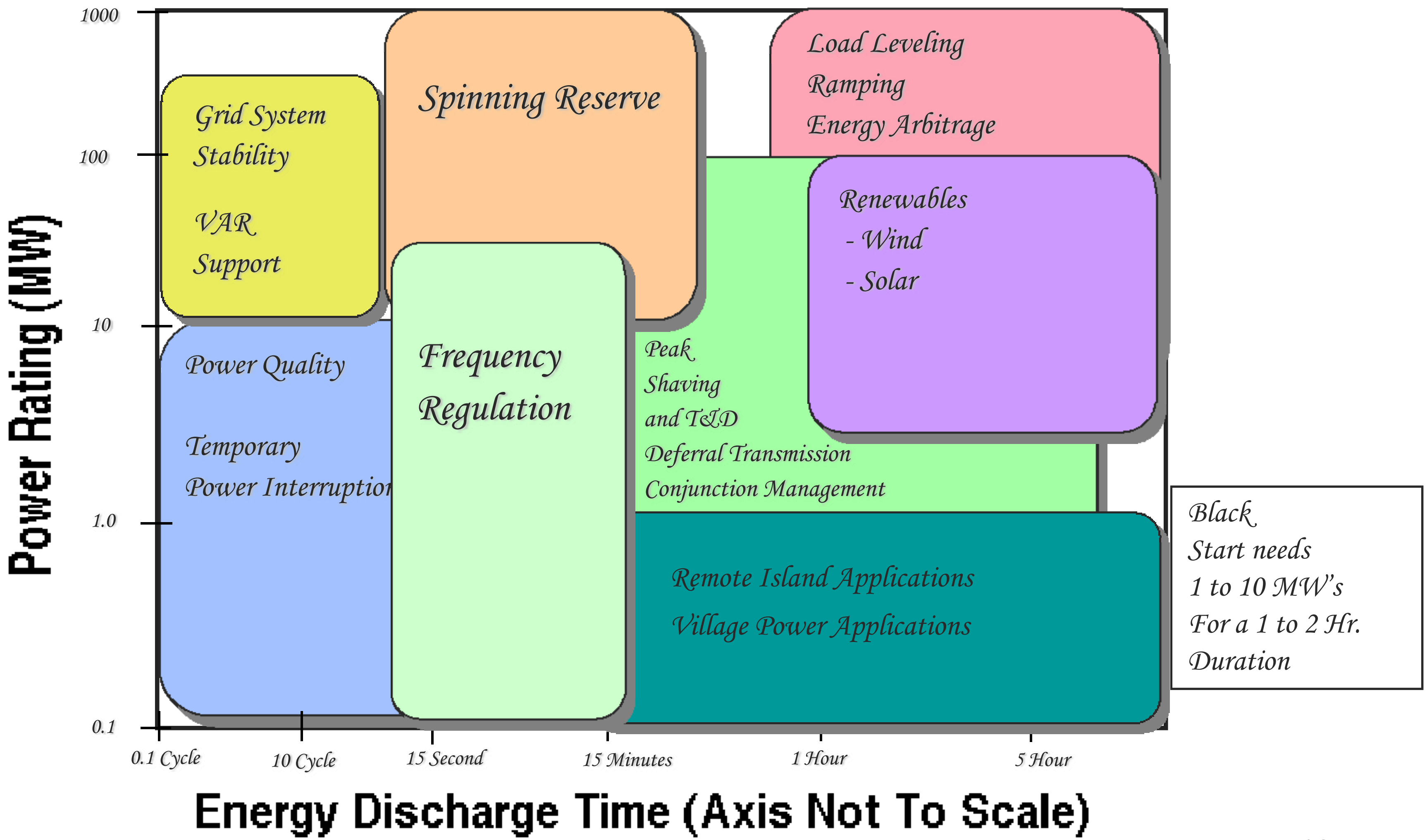


Automated DR Potential



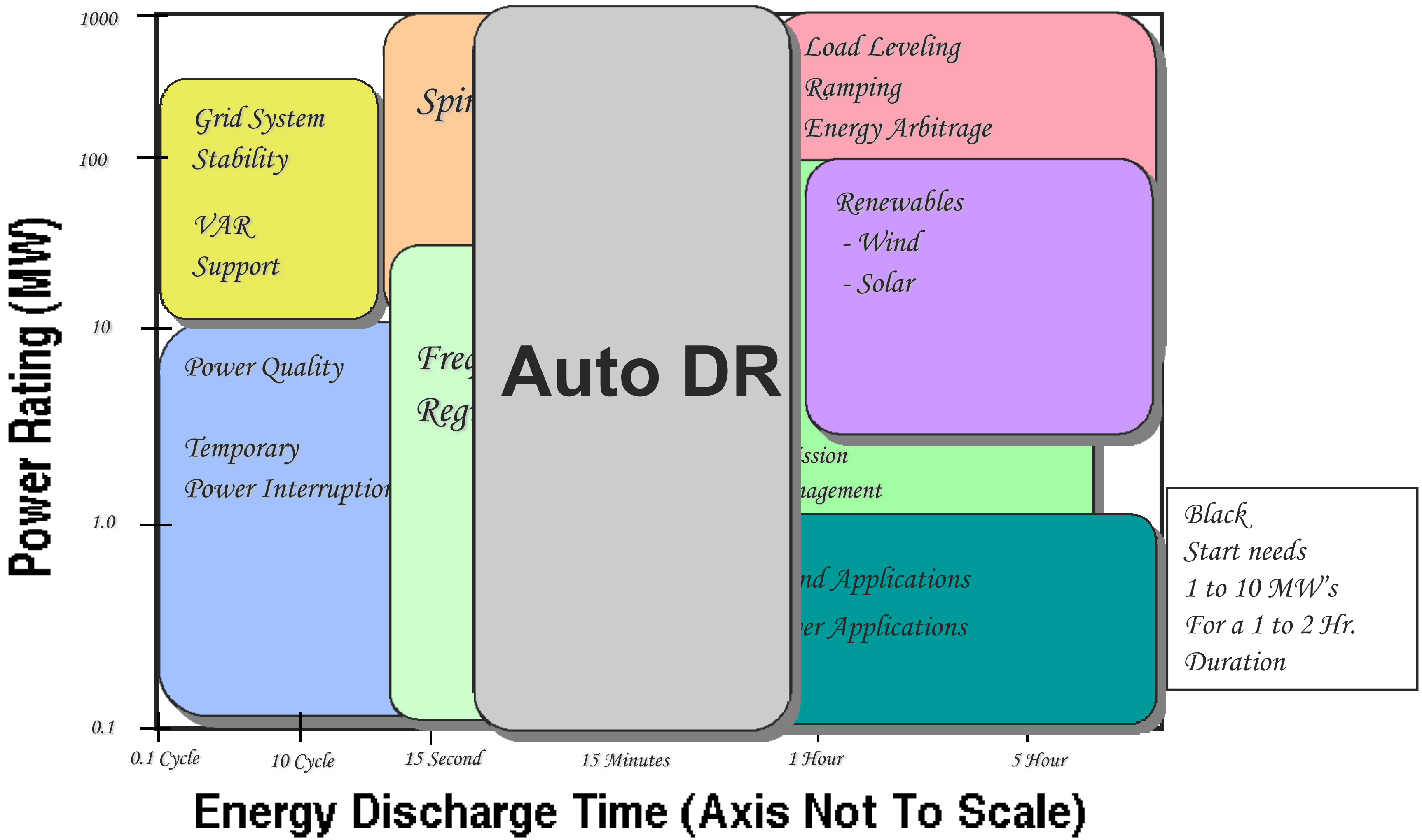
Electric Energy Storage Applications

(All Boundaries Of Regions Displayed Are Approximate)



Auto DR Grid Service Application Potential

(All Boundaries Of Regions Displayed Are Approximate)

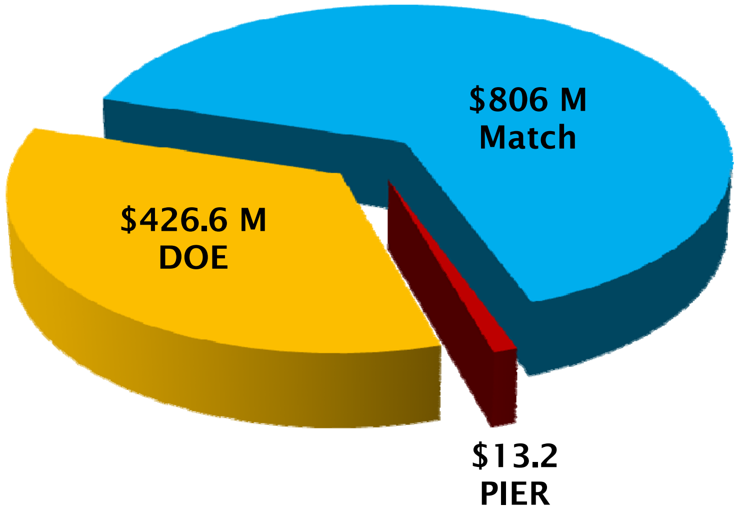


Smart Grid ARRA Projects

15 California Based Projects Totaling $1.25 Billion

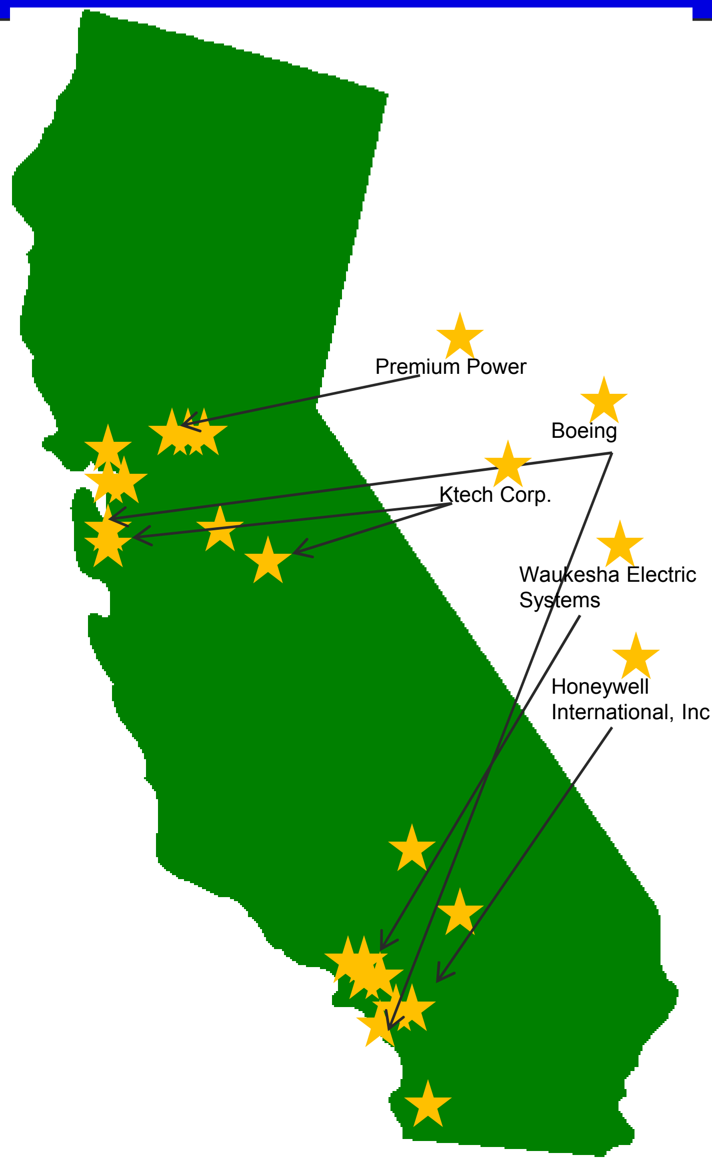
Why PIER Provided Cost-Share For ARRA

- Without PIER funding DOE would not award *(DOE recognizes CA's leadership in Smart Grid)*
- Early Warning To Identify How Smart Grid Is Developing
- Ensure Consistency Among California Projects
- One Smart Grid for California *(Energy Commission Is The Common Participant For All Projects)*



- Smart Meters
- Grid Security
- Communication
- Phasors
- Storage
- PHEV
- Consumer Behavior
- Demand Response
- Standards
- HAN

ARRA Smart Grid in California



Total Project Value to CA - $1.3 Billion

- City of Glendale Water & Power
- Modesto Irrigation District
- Burbank Water & Power
- City of Anaheim
- Electric Power Group (WECC sub-contractor)
- Pacific Gas & Electric (WECC sub-contractor)
- Sacramento Municipal Utility District
- San Diego Gas & Electric
- Honeywell International, Inc. (Headquarters in MA, work being done in Southern CA)
- Los Angeles Department of Water & Power
- Southern California Edison
- Boeing (Headquarters in MO, work being done in Sunnyvale and Huntington Beach, CA)
- Waukesha Electric Systems (Headquarters in WI, work being done in Irvine, CA)
- Primus Power
- SEEO Inc.
- Southern California Edison
- Pacific Gas & Electric
- Amber Kinetics
- Ktech Corp. (Headquarters in NM, work being done in Sunnyvale and Snelling, CA)
- Sacramento Municipal Utility District (sub-contractor to Premium Power, Headquarters in MA)

Workshop Agenda Review

Follow-up Questions

Michael Gravely

California Energy Commission

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California ISO
Your Link to Power

California ISO initiatives to facilitate renewable integration

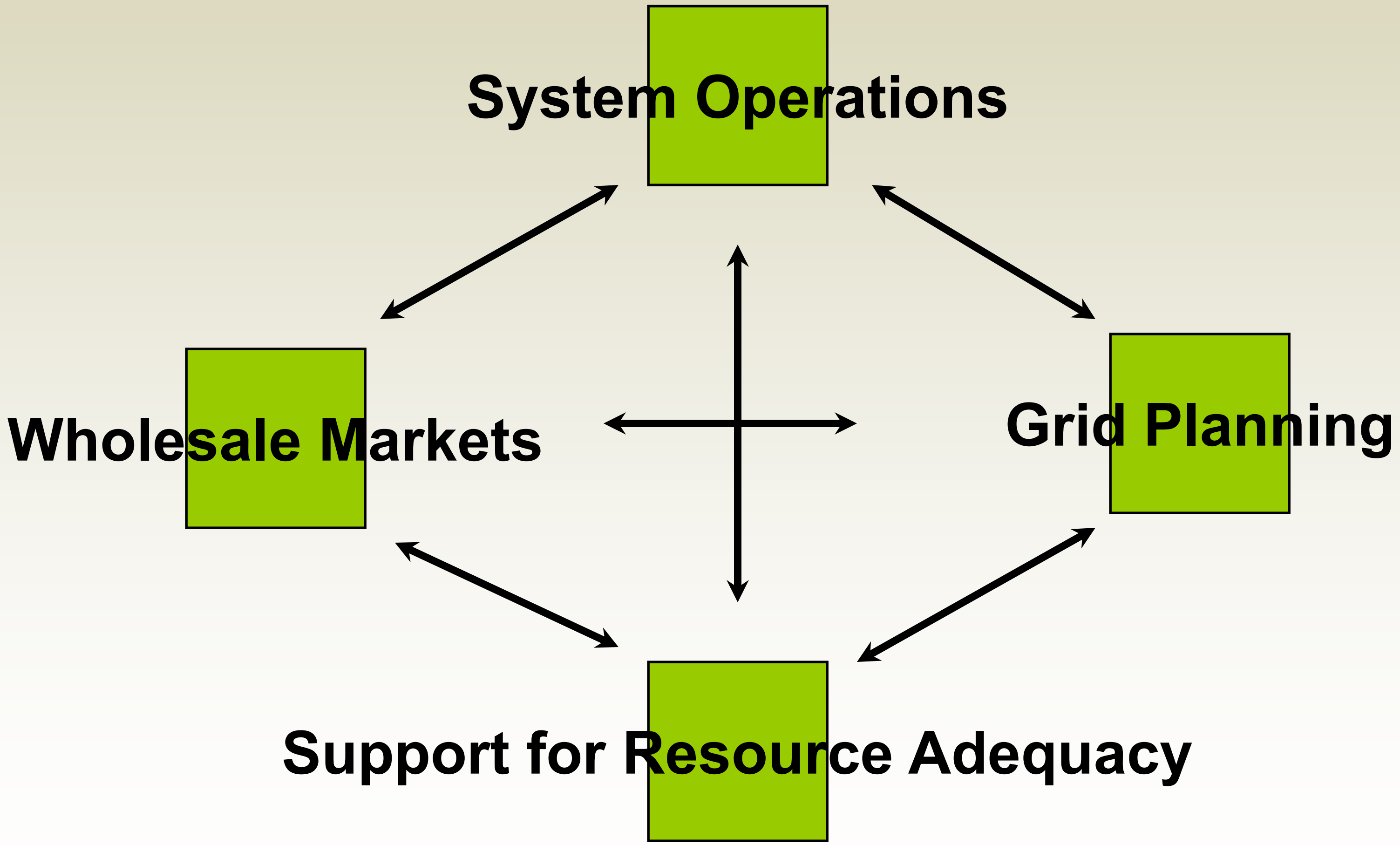
Udi Helman

CEC IEPR Staff Workshop

Technologies to Support Renewable Integration

California Energy Commission, November 16, 2010

ISO is undertaking initiatives across all its core functions to advance renewable and storage integration



Some key objectives and principles for ISO initiatives relevant to demand response and storage

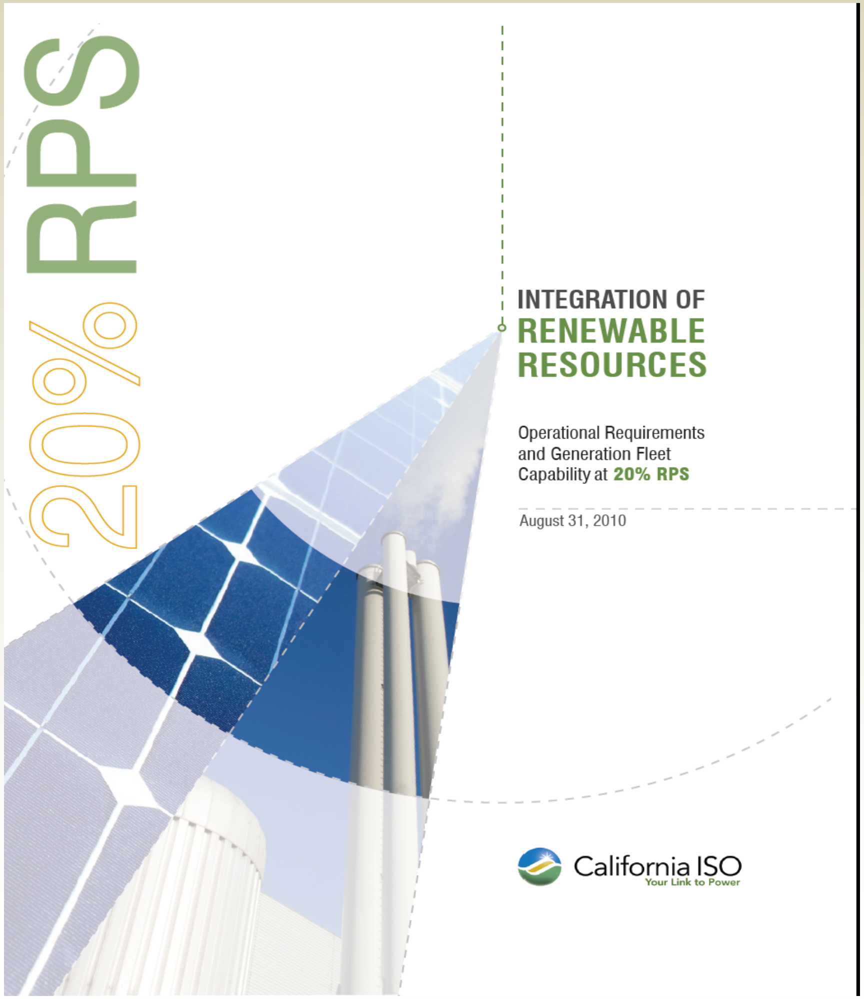
- Provide multi-year operational and market analysis to inform technology and infrastructure investment decisions
- Reduce barriers for demand response and storage technologies to participate in existing wholesale markets and any new market products
- Remain technology neutral: all New market products will not be technology-specific
- Prioritize changes to ISO market and system operations year-by-year

ISO Study of renewable integration at 20% RPS: A 2-3 year look-ahead

- Published August 31, 2010

- First high RPS operational study to consider both wind and solar resources at high RPS

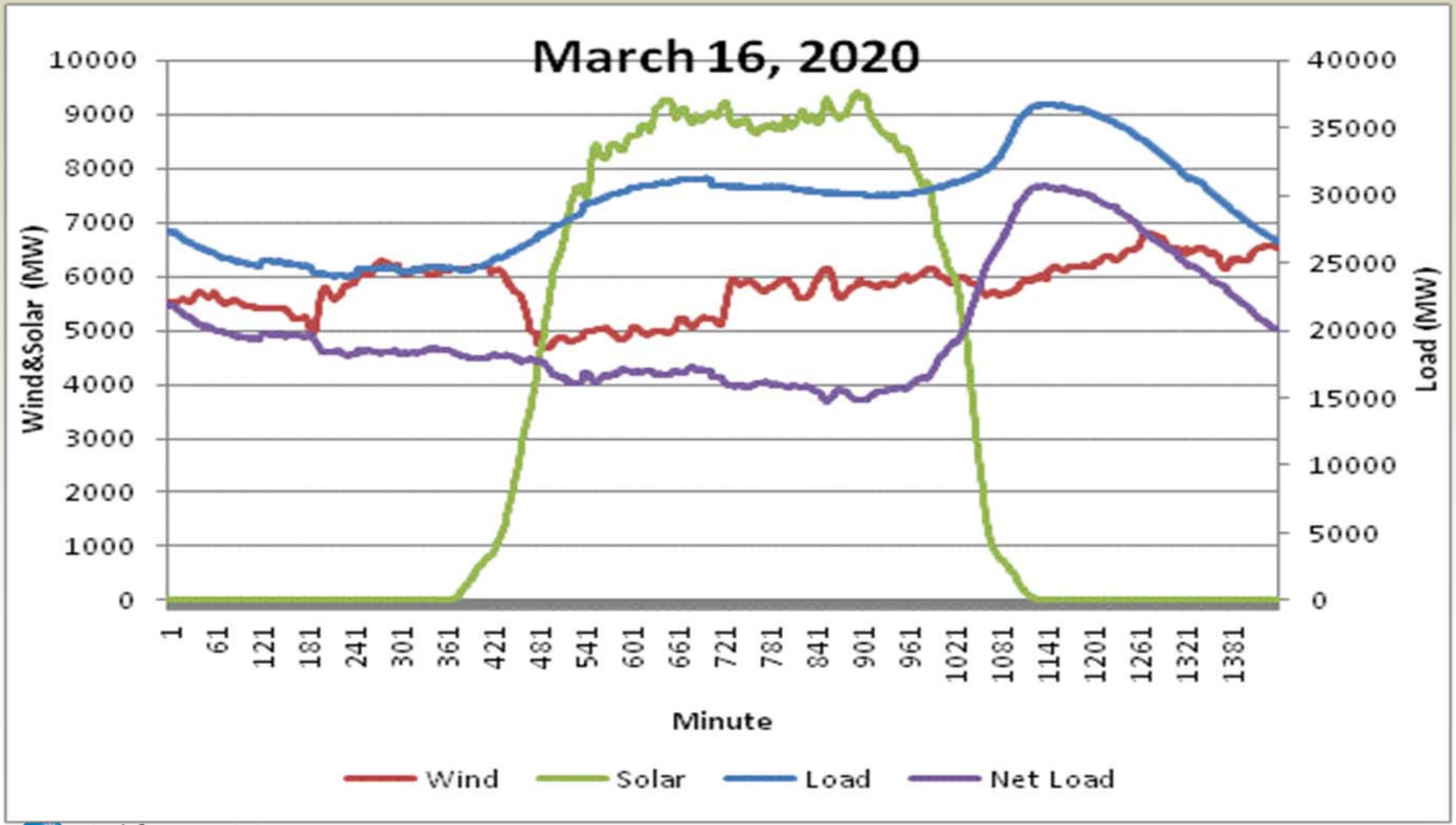
- Study, technical appendix and comments available at http://www.caiso.com/27be/27beb7931d800.html



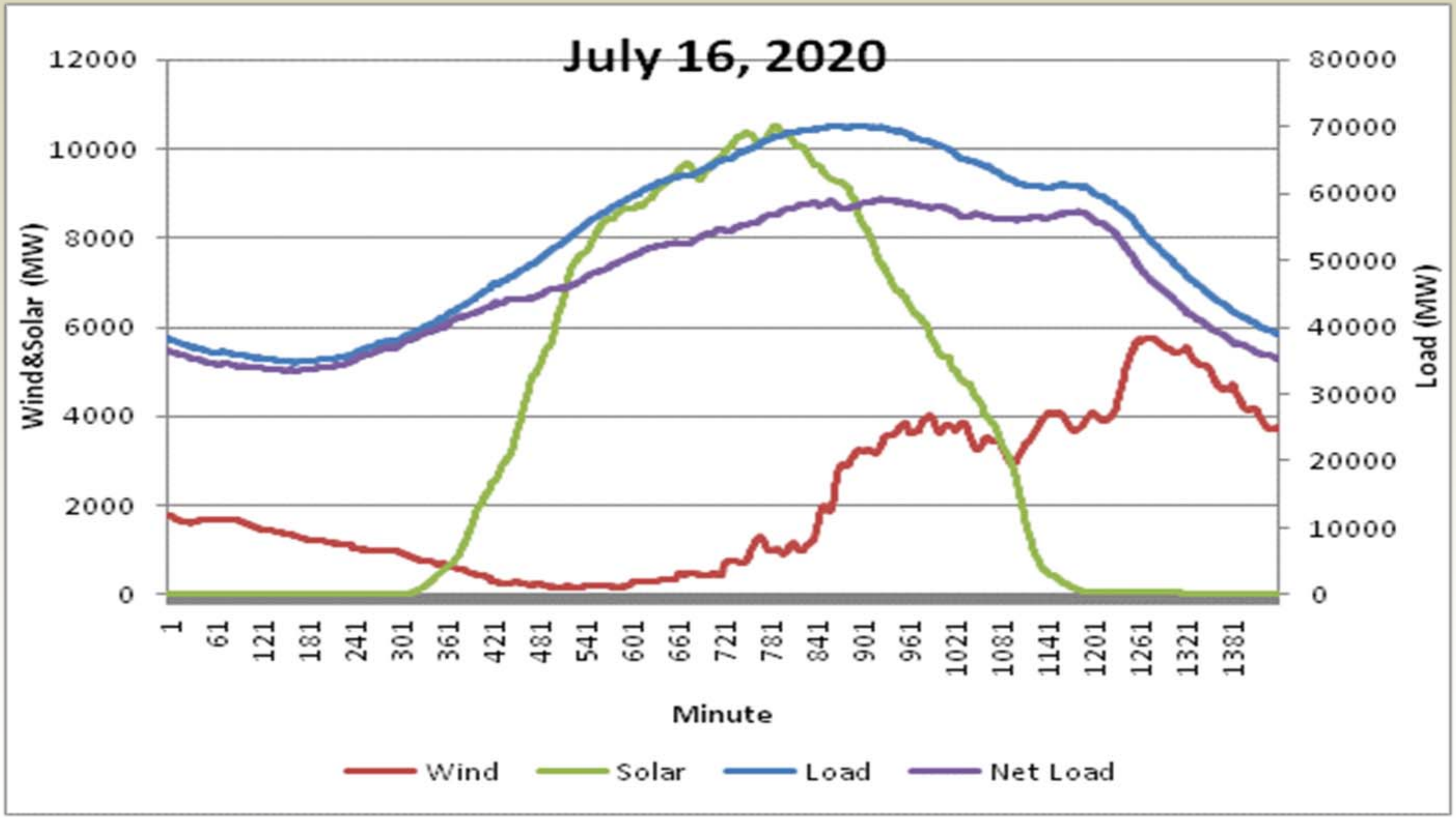
ISO operational and market simulation results of 33% RPS in 2020

- Initial results in PowerPoint format are available here:
  - http://www.cpuc.ca.gov/PUC/energy/Renewables/100824_workshop.htm
- More results to be released at CPUC renewable integration model methodologies workshop on November 30, 2010

Variability increases dramatically by 33% RPS: Simulated profiles for "March 16, 2020", CPUC 33% Reference Case (2009 version)



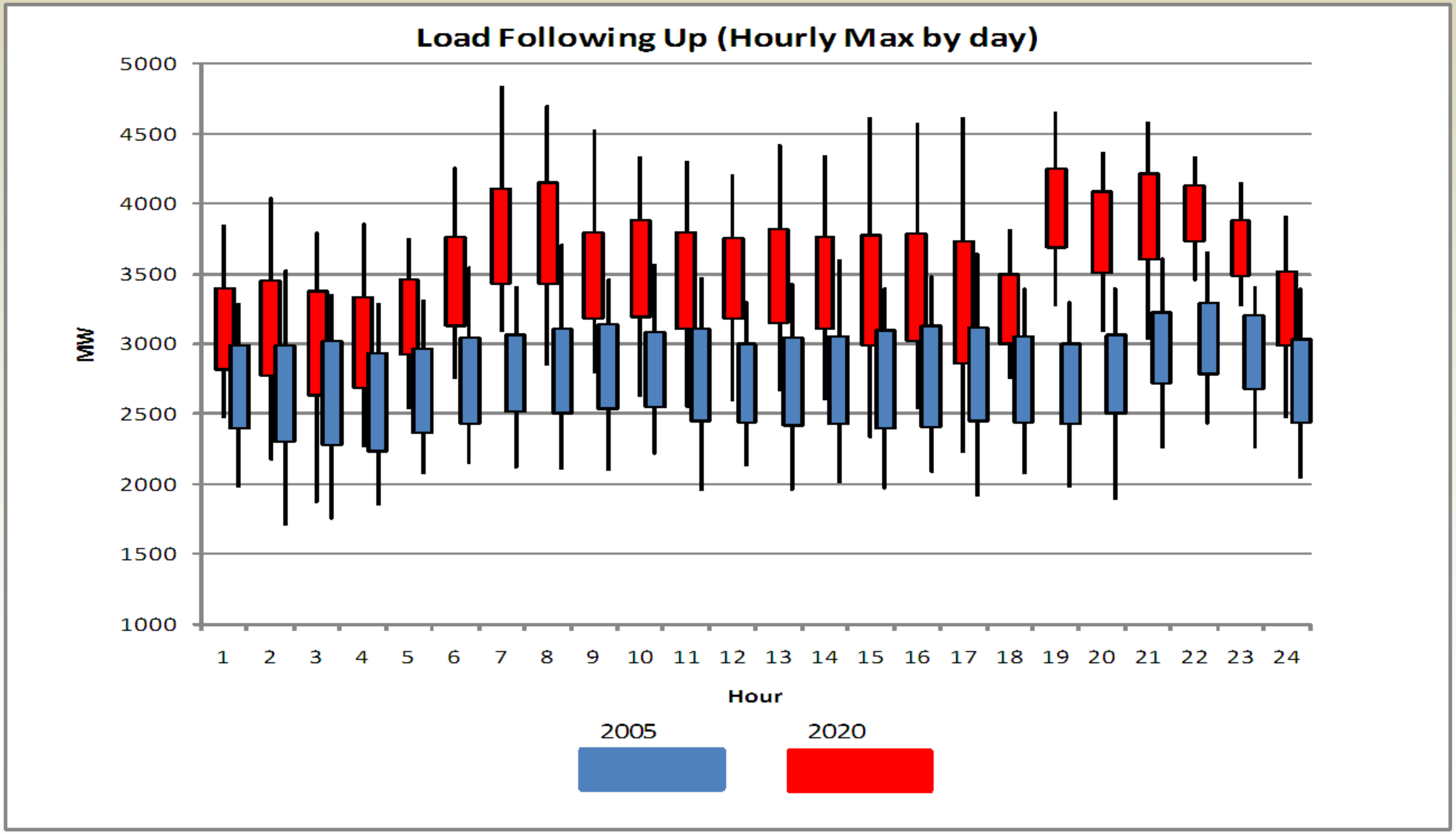
Variability increases dramatically by 33% RPS: Simulated profiles for "July 16, 2020", CPUC 33% Reference Case (2009 version)



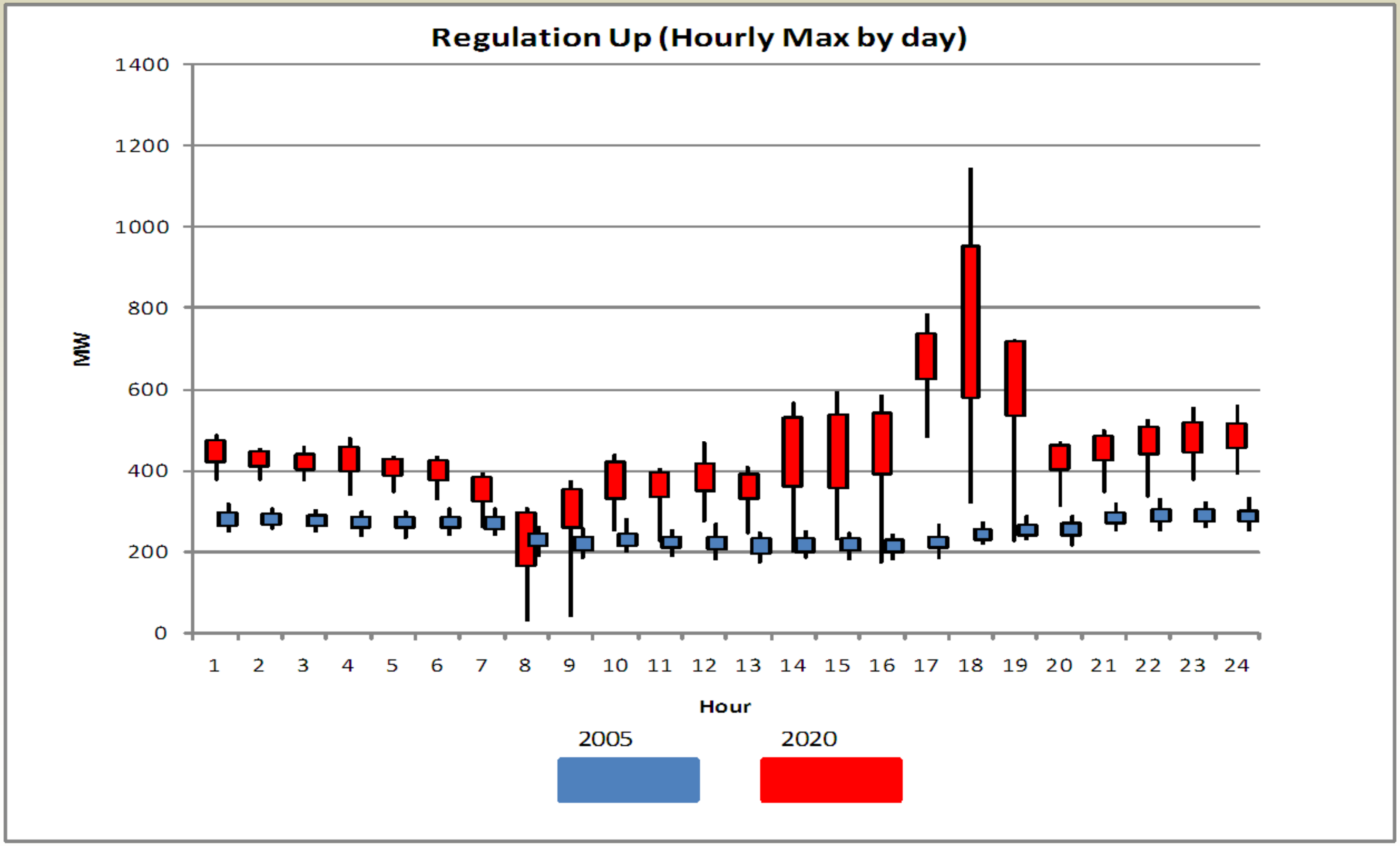
Some key findings from renewable integration studies

- Significant increases in intra-hourly load-following/renewable-following requirements, varying by season and hour
- Significant increases in Regulation requirements, varying by season and hour
- Energy market prices are expected to decline as renewable energy displaces gas across the day (wind + solar)
  - However, real-time energy prices (load-following) will become more volatile
- Ancillary service market prices will be a function of several factors, including the additional requirements and availability of certified resources

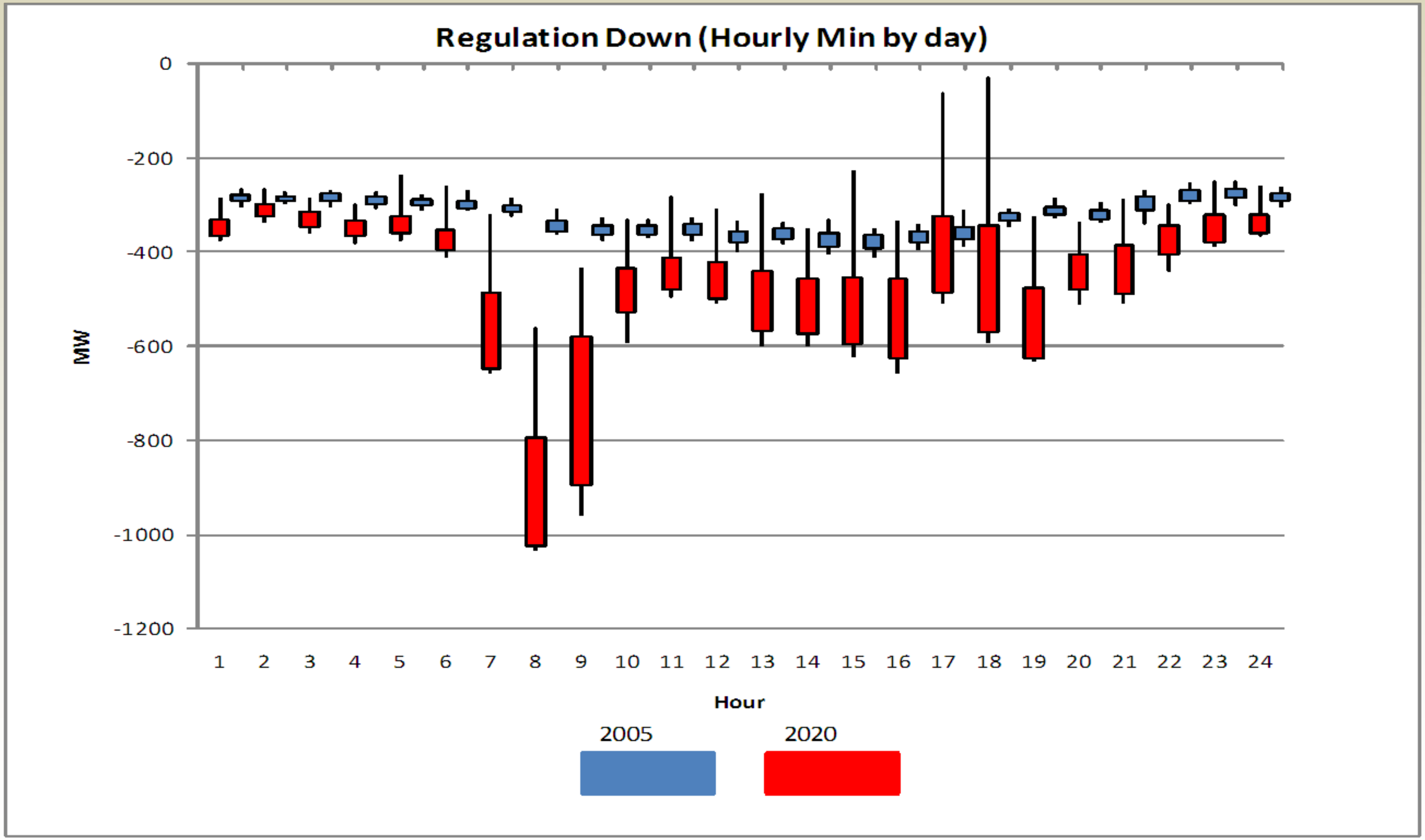
Example: Simulated increase in load-following up under 33% RPS in 2020, CPUC 33% Reference Case (2009 version)



Simulated increase in regulation up under 33% RPS in 2020, CPUC 33% Reference Case (2009 version)



Simulated increase in regulation down under 33% RPS in 2020, CPUC 33% Reference Case (2009 version)



ISO is providing inventories of existing generation fleet capabilities relevant to renewable integration

- By operational characteristic:
  - Ramp rates
  - Start-up times
  - Regulation-certified ramp rates and ranges

- By unit type:
  - Existing fleet, both with and without Once-Through Cooling (OTC) (20% study)
  - Alternative future fleet mixes (33% studies)

Regulation-certified capacity of the ISO generation fleet by ramp rate, 2010

Generation Type		Regulation Ramp Rates (RR) (MW/min) by Category				
		1 ≤ RR < 5	5 ≤ RR < 10	10 ≤ RR < 20	20 ≤ RR	Total MW
Non-OTC Units	Combined Cycle	719	1693	2171	347	4930
	Dynamic Schedule				775	775
	Gas Turbine	20	20	159		199
	Hydro	319	1020	891	1880	4110
	Other				4	4
	Pump/Storage				969	969
	Steam	316	100			416
	Not specified				525	525
Non-OTC Unit Total		1374	2833	3221	4500	11928
OTC units	Combined Cycle		370			370
	Steam	2442	3599	500	1060	7601
OTC Unit total		2442	3969	500	1060	7971
All Units Total		3816	6802	3721	5560	19899

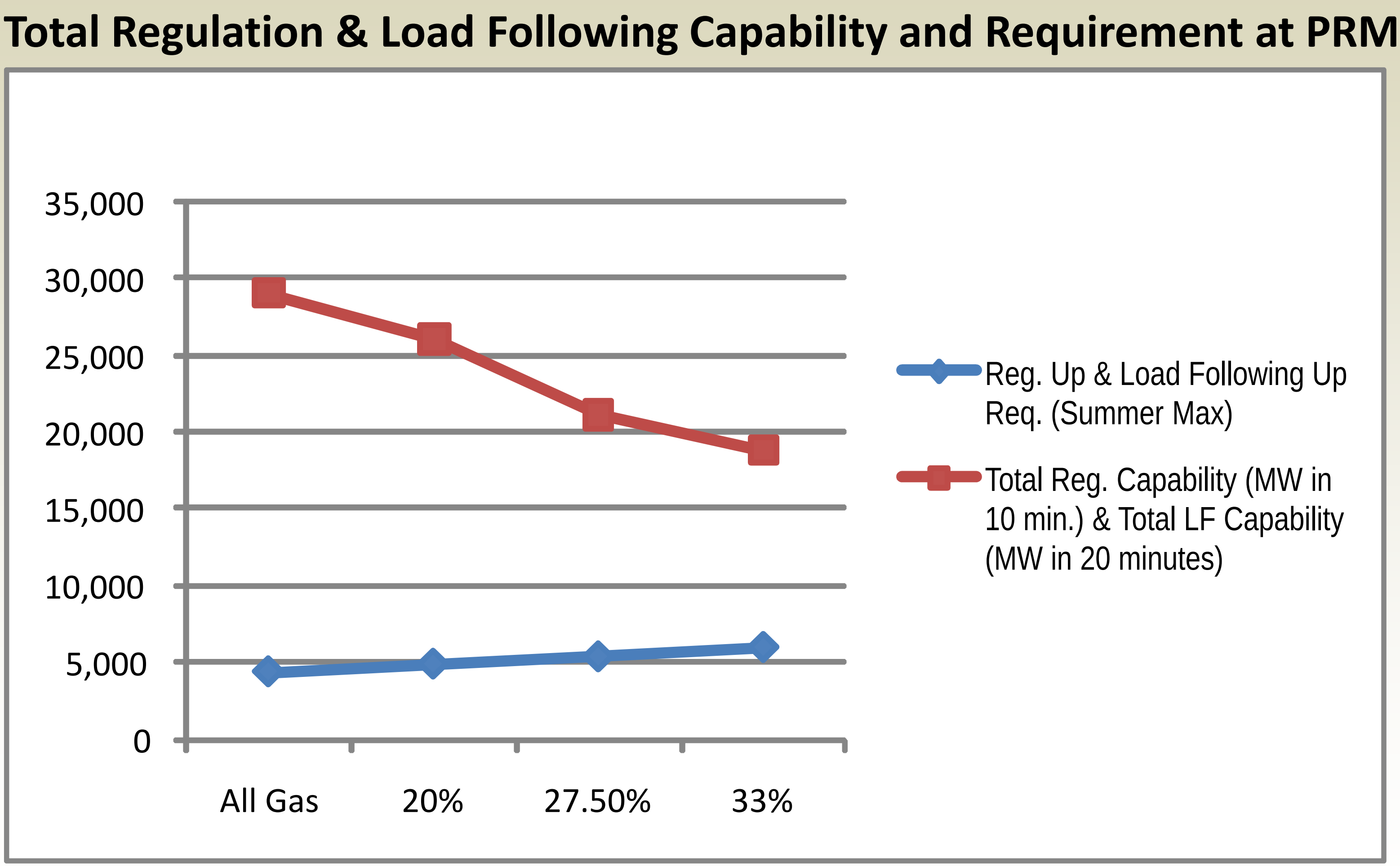
California ISO
Your Link to Power

Source: CAISO, 20% RPS integration study, pg. 70

As renewables get more capacity credits, the flexibility capability of the conventional fleet declines

Case Name		All Gas Final	20% Final	27.5% Final	33% Final	High DG PRM Only	High OOS PRM Only
Analysis of All Resources at 17% PRM That Provide Regulation and Load Following							
Total of Regulation Ranges (MW)		22,288	21,271	19,627	18,837	18,237	20,124
Percent Reduction From All Gas			4.6%	11.9%	15.5%	18.2%	9.7%
Total of all Load Following Ranges (MW)		33,458	31,448	28,178	26,618	25,418	29,078
Percent Reduction From All Gas			6.0%	15.8%	20.4%	24.0%	13.1%
Total of all Regulation Capability (MW in 10 minutes)		9,265	8,248	6,604	5,814	5,214	7,101
Percent Reduction From All Gas			11.0%	28.7%	37.2%	43.7%	23.4%
Total of all LF Capability (MW in 20 minutes)		19,811	17,801	14,531	12,971	11,771	15,431
Percent Reduction From All Gas			10.1%	26.7%	34.5%	40.6%	22.1%
Ratio: Total of all Reg Capability to Total of all Ranges (%)		41.6%	38.8%	33.6%	30.9%	28.6%	35.3%
Percent Reduction From All Gas		0.0%	6.7%	19.1%	25.8%	31.2%	15.1%
Ratio: Total of all LF Capability to Total of all Ranges (%)		59.2%	56.6%	51.6%	48.7%	46.3%	53.1%
Percent Reduction From All Gas			4.4%	12.9%	17.7%	21.8%	10.4%

By 2020, operational needs for renewable integration and operational capabilities of conventional resources may be trending in opposite directions*



* Based on analysis that does not consider additional storage

Some Next Steps for 2010-11

- 33% RPS production simulations will produce initial results over the next month, but then substantial revisions to reflect updated CPUC scenarios and methodological changes
- Additional focus on intra-hourly simulation in 2020
- More focused evaluation of storage and demand response in renewable integration simulations
- Market initiative in 2010-11 to introduce Regulation Energy Management for energy limited resources

Research Evaluation of Wind Generation, Solar Generation, and Storage Impact on the California Grid

CEC IEPR Staff Workshop

Technologies to Support Renewable Integration

(Energy Storage and Automated Demand Response)

November 16, 2010 Sacramento, CA

Report Prepared for:

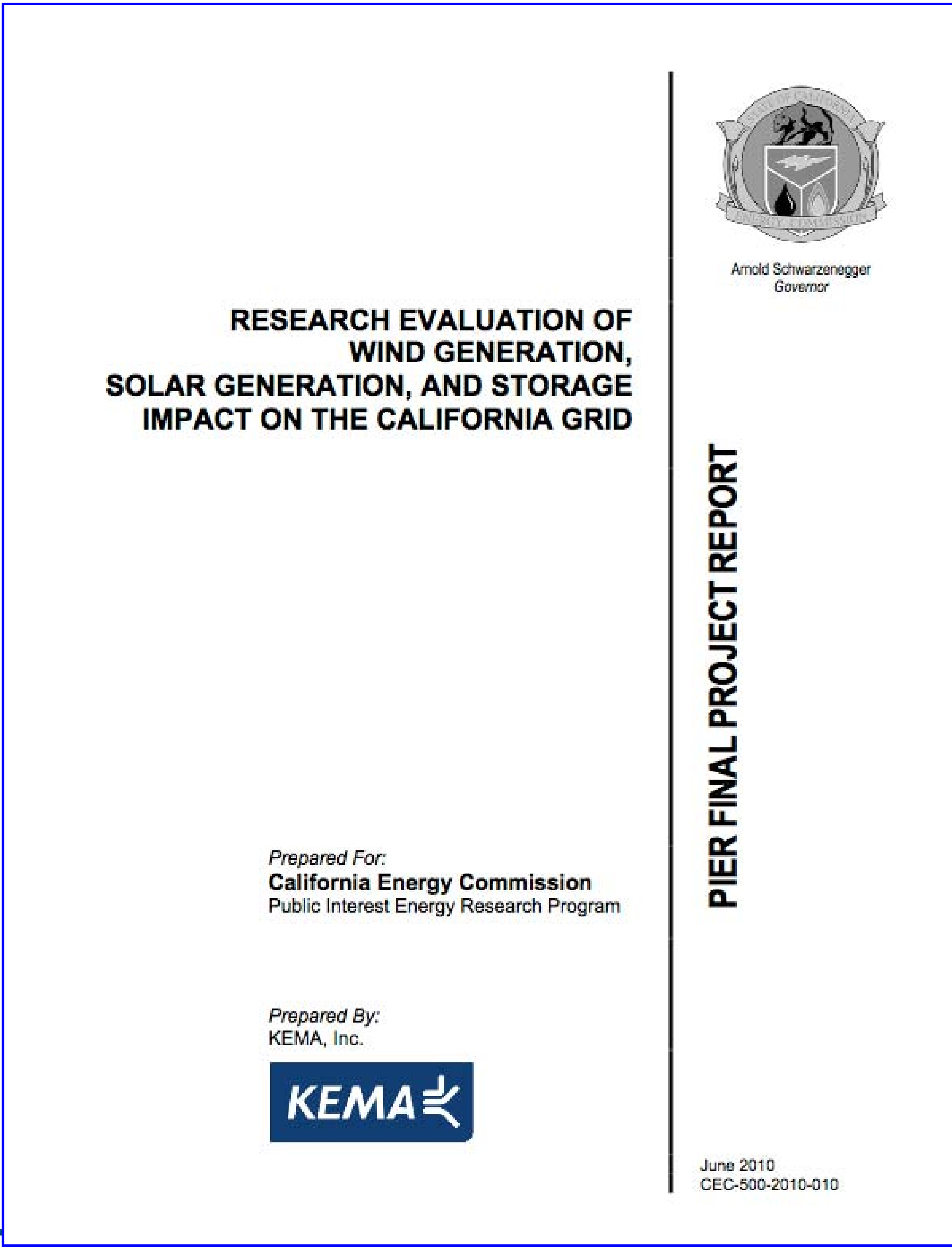
California Energy Commission

Public Interest Energy Research Program

CEC-500-2010-010, June 2010

Report published on CEC website in June, 2010

The report describes the new analytical model that KEMA developed to analyze the minute to minute variable of wind and solar renewable resources, the ability of conventional generation resources to the variability, and the role that energy storage can fulfill to assist with the integration of large amounts of renewable resources.


Arnold Schwarzenegger
Governor

RESEARCH EVALUATION OF
WIND GENERATION,
SOLAR GENERATION, AND STORAGE
IMPACT ON THE CALIFORNIA GRID

PIER FINAL PROJECT REPORT

Prepared For:
California Energy Commission
Public Interest Energy Research Program

Prepared By:
KEMA, Inc.

June 2010
CEC-500-2010-010

Project Objectives

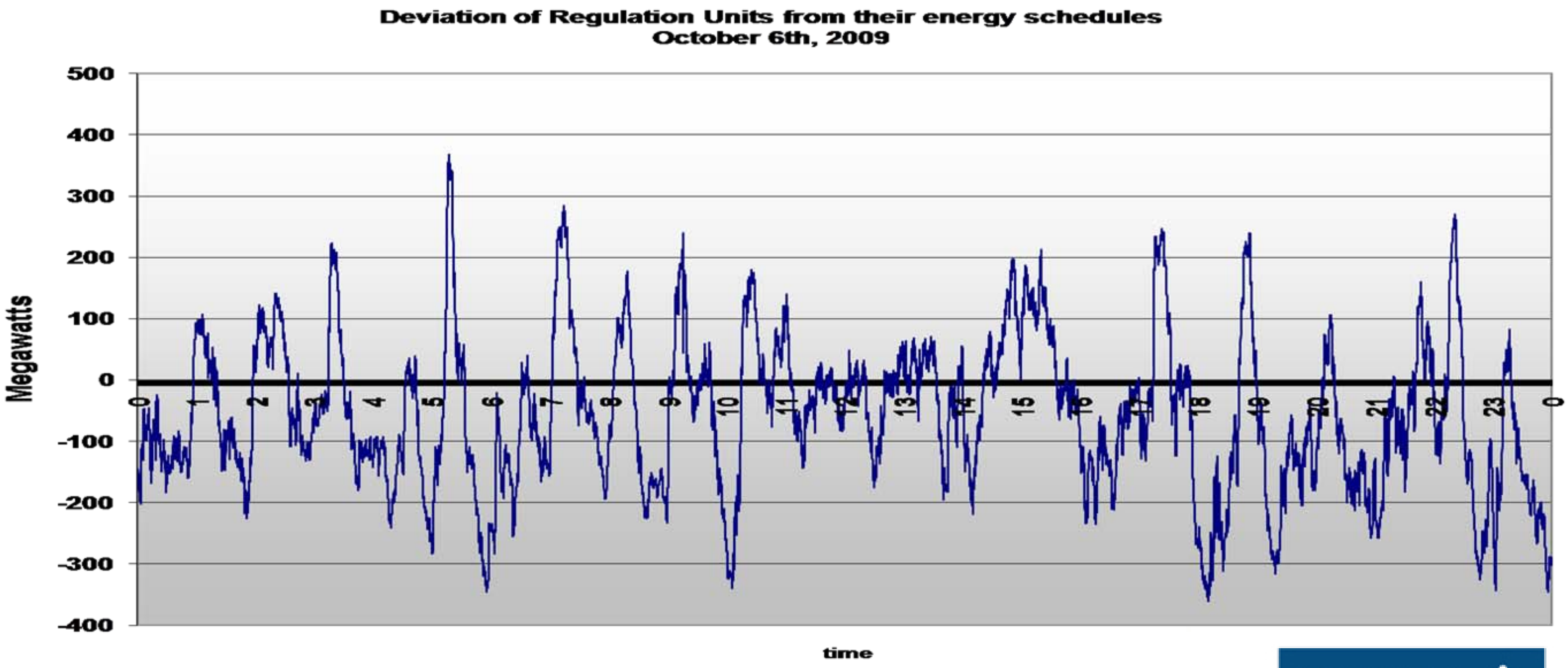
- Evaluate Impact of 20% and 33% Renewable Portfolios on California Grid Operations
  – AGC Performance, Load Following Ability
- Determine Ancillary Services (Regulation, Governor Response) Requirements of 20% and 33% Renewable Portfolios
- Determine Requirements for Use of Large Scale Grid Connected Storage for Ancillary Services
- Evaluate Storage Equivalent of a 100MW Combustion Turbine
- Determine Policy Issues Affecting Storage Development in California

Project Overview

- Research examined the effects of high renewable penetration on intra-hour system operations of the California Independent System Operator (California ISO) control area
- Examined how grid-connected electricity storage might be used to accommodate the effects of renewables on the system
- Utilized KEMA's high-fidelity model (KERMIT) to analyze the effects of planned additions of renewable generation on electric system performance
- Research focused on required changes to current systems to balance generation and load second-by-second and minute-by-minute
- Study also assessed potential benefits of deploying grid-connected electricity storage to provide some of the required components—including regulation, spinning reserves, automatic governor control response, and balancing energy—necessary for integrating large amounts renewable generation.

Context

- Automatic generation control operates the generators that supply regulation services (up and down) every 4 seconds to keep system frequency and net interchange error as scheduled. The *real-time dispatch* buys and sells energy from generators participating in the real-time or balancing market every five minutes to adjust generator schedules to track a system's load changes.



Study Highlights

- Model of California generators, loads and WECC regions
  - Second by second simulation for 24 hours of California system
  - Model of 4 second EMS dispatch of regulation
  - Model of Market dispatch of supplemental energy
  - Model of wind and solar variability – but limited solar data was available
- Number of days studied was very limited
  - Intensive data collection / validation effort involved
- Results clearly showed that:
  - Energy Ramps in less than 1 hour is going to be a major issue
  - Increased Renewables will Increase regulation needs significantly
  - Large amounts of regulation alone will not solve the problem
  - Energy Storage with 2 hours of capacity or more is an (expensive) solution
  - This simulation tool can be a major asset for renewable integration studies
  - AGC Algorithm development desirable for renewables integration

Calibrated to System Frequency Response (Unit Trip) and to System AGC Performance (CPS, ACE PSD)

Time Domain, Problems, and Methods

Replacement Reserves

Harmonics

Frequency Response

Capacity

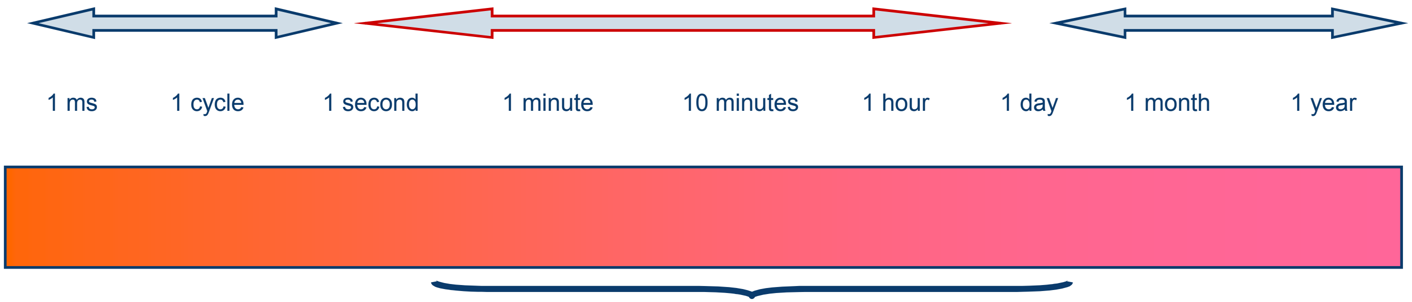
Protection

Regulation

Economics

Stability

Balancing



Statistical Analysis of AGC and Balancing

Production Costing
Market Simulation
Expansion Planning

Transient and Harmonics Analysis
Short Circuit

Governor Response

Spinning and Short Term Reserves

Storage

Replacement Reserves

Emissions Performance

Long Term Generation, Transmission, DSM, and DG Investments

KEMA Energy Ecology Model

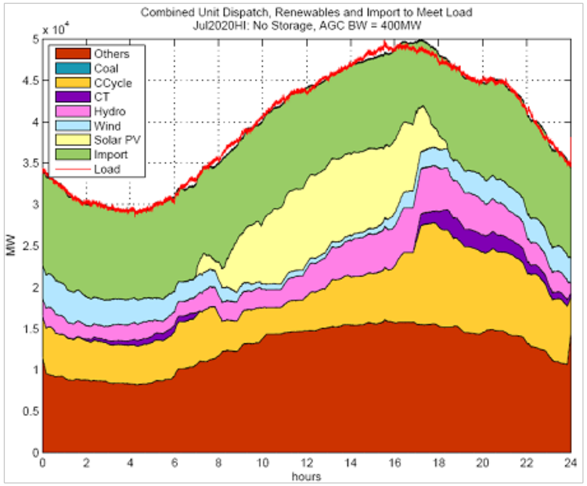
KEMA Simulation Tool

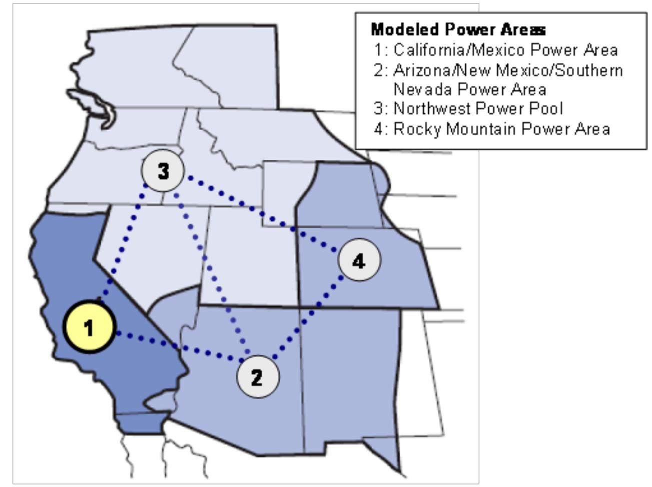
Power Factory
PSSE
DigSilent

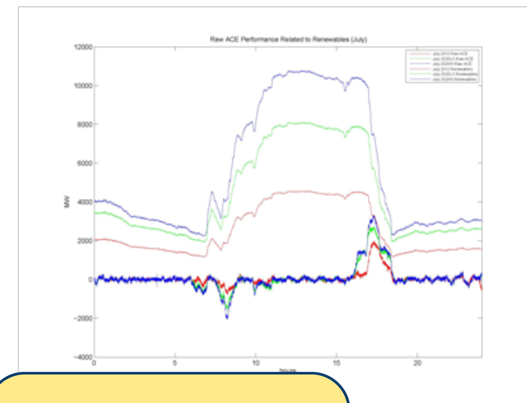
ProMod
GE MAP

KEMA

KEMA Simulation Tool







Generator Trip

Load Rejection

Wind Power Forecast versus Actual

Volatility in Renewable Resources

Standard Inputs:
Load
Plant Schedules
Generation Portfolio
Grid Parameters
Market/Balancing

Scenarios:
Increasing Wind
Adding Reserves
Storage Parameters
Test AGC Parameters
Trip Events

KERMIT
24h Simulation

Generation
- **Conventional**
- **Renewable**

Frequency Response

Inter-connection

Real Time Market

Outputs:
ACE
Power Plant MW Outputs
Area Interchange
Frequency Deviation

KEMA

Data Summary

- We have time-series data for the following days, which are used during calibration process:
  - 06/05/2008
  - 07/09/2008
  - 10/20/2008
  - 02/09/2009
  - 04/12/2009

- For simulation of future years: Existing time series were scaled up to reflect the projected capacities in 2012 and 2020.

Plant Capacity in Megawatts

Year	2009	2012	2020 low	2020 high
PV	400	830	3234	3234
CST	400	996	7297	10000
Wind	3000	5917	10972	13000

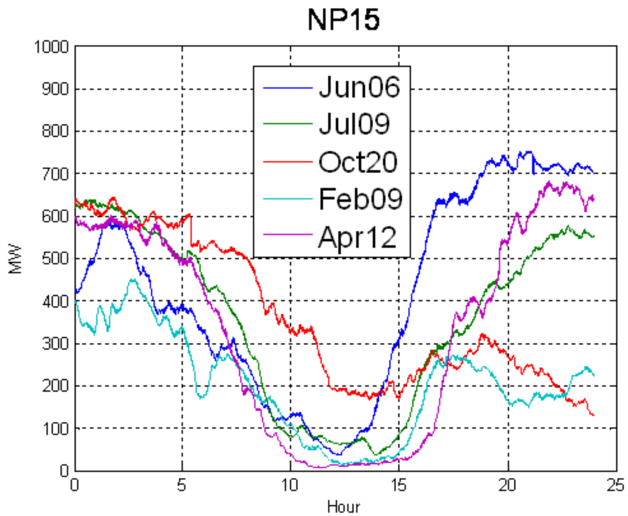
KEMA

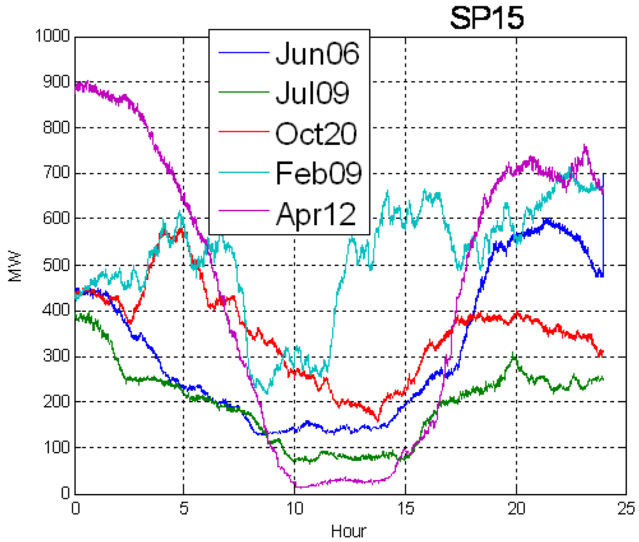
Wind power

- Available from CAISO as time series.
  - Time series of the past (see side graphs), were scaled up according to capacity table
- Appropriate weightings were used to reflect location of future windfarms including wind in BPA Control Area that has to be balanced by CA ISO

Plant Capacity in Megawatts

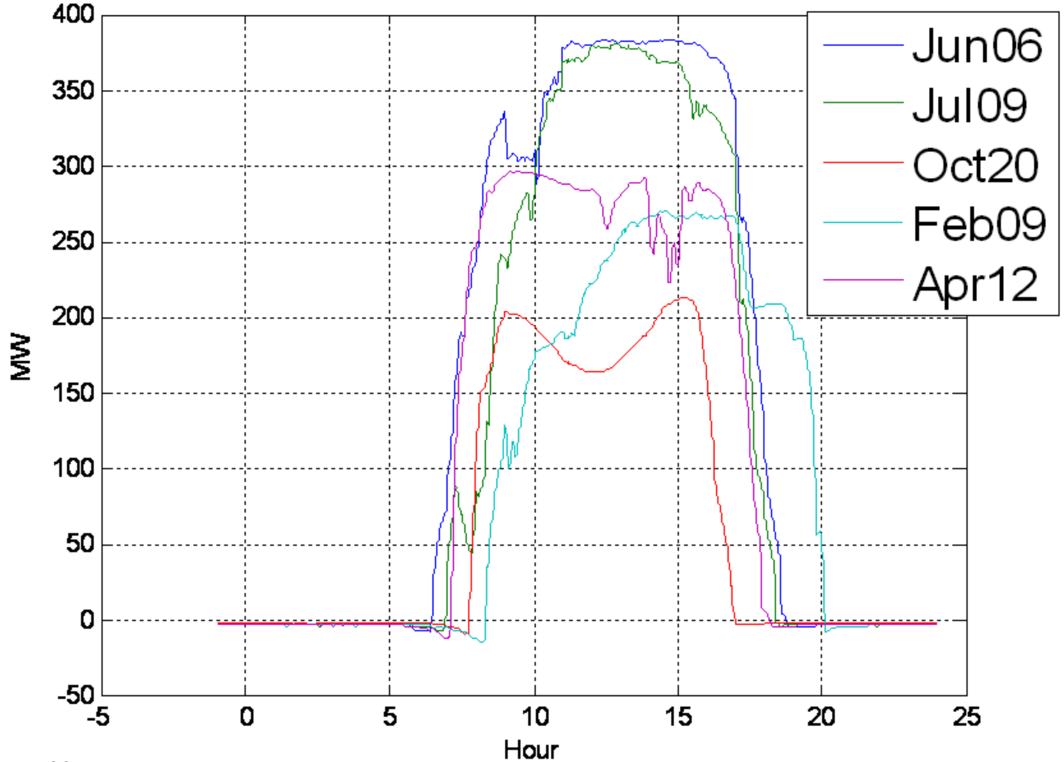
Year	2009	2012	2020 low	2020 high
Wind	3000	5917	10972	13000





Concentrated Solar Thermal

- Available from CAISO as time series
- Afternoon production extended two hours to reflect gas firing
- Scaled up to reflect capacity table
  - Belief is that geographic diversity will be minimal



Plant Capacity in Megawatts

Year	2009	2012	2020 low	2020 high
CST	400	996	7297	10000

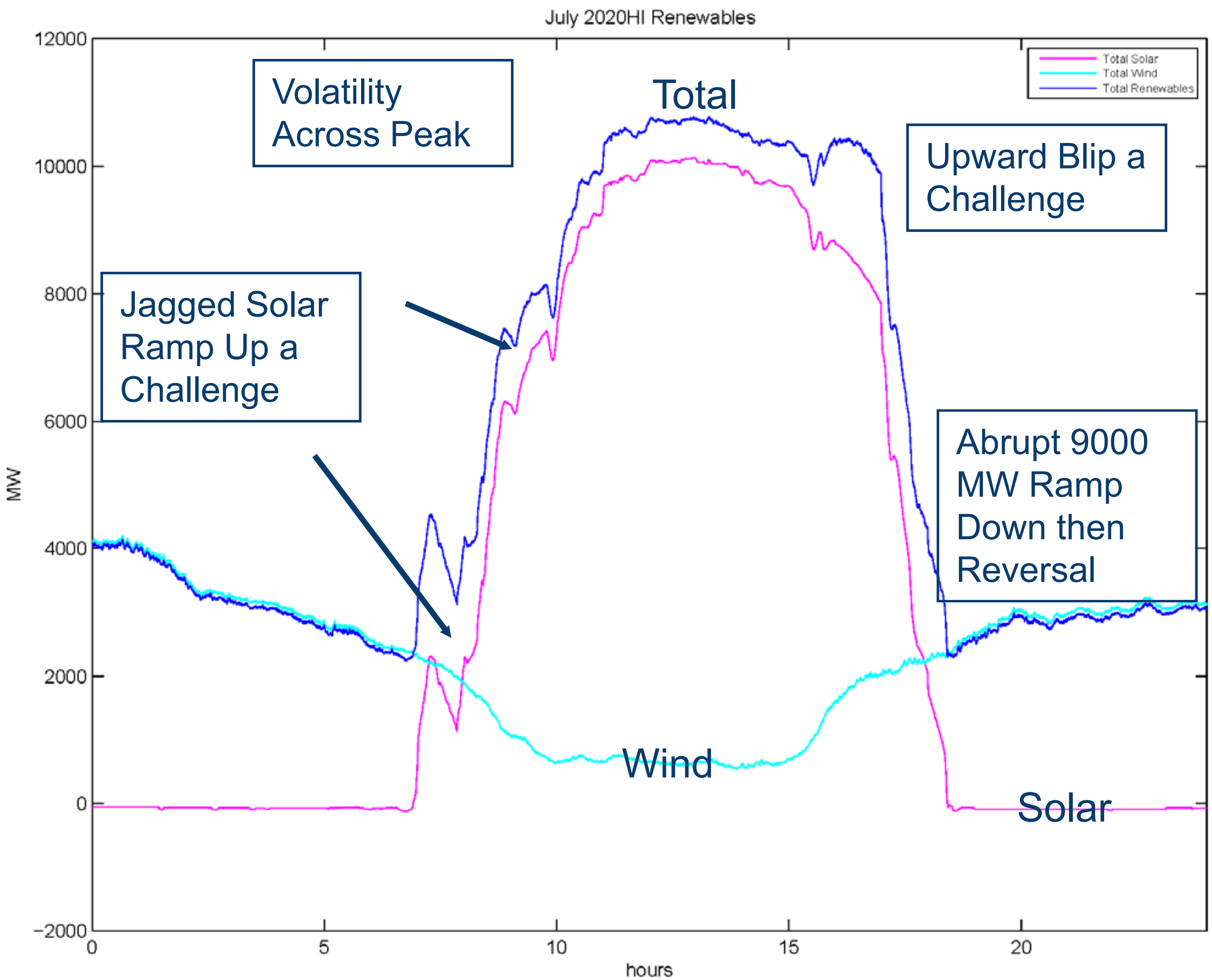
Photovoltaic

- Lacking measurements, we will use simulated time series.
- KERMIT has PV model:
  - Direct inputs are time series for Temperature (degC) and Solar intensity (W/m^2).
    - From NOAA site, we can get these data for selected days for a particular locations in the US.
  - Indirect inputs are related to panel characteristics (electrical and tilt), the surroundings (clouds, abedo)
- The next slide shows simulated time series for a 100MW fictitious PV farm in N. California.
- Such time series will be scaled up for 2012 and 2020, based on the capacity table below.

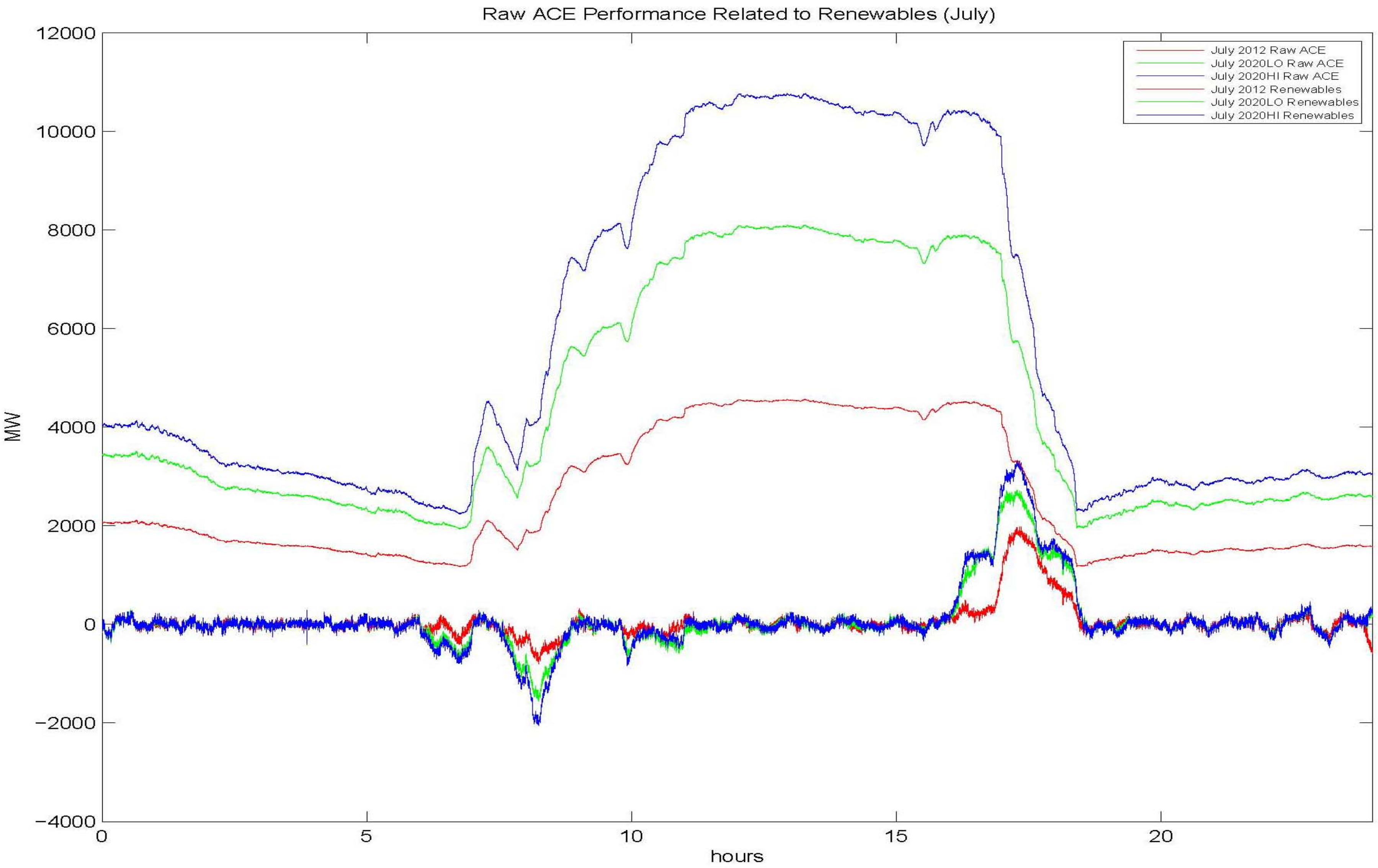
Plant Capacity in Megawatts

Year	2009	2012	2020 low	2020 high
PV	400	830	3234	3234

July Renewables – 2020 High Penetration

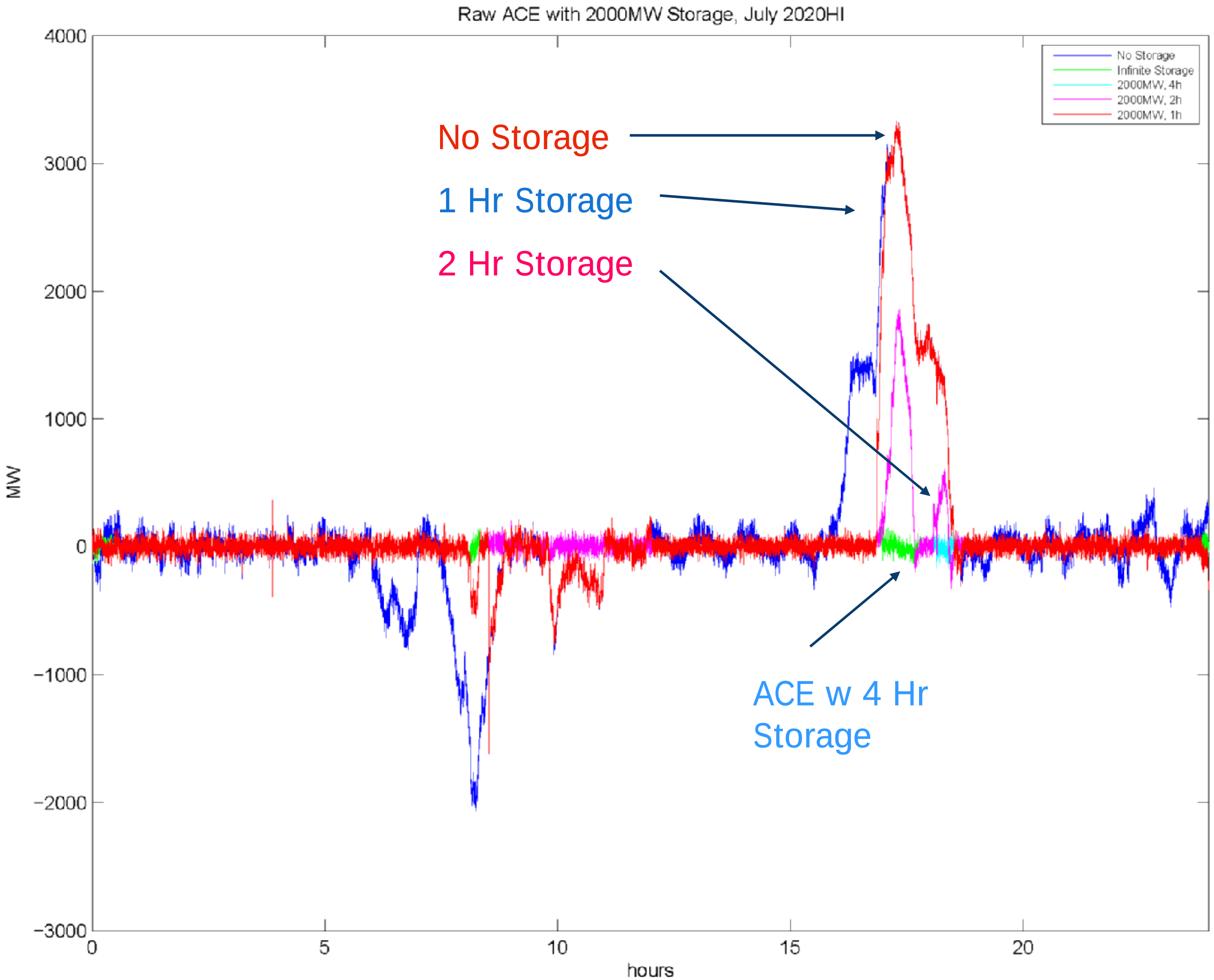


July Day – ACE across renewable scenarios



Evaluating Performance - 2000 MW Storage, July 2020HI Scenario

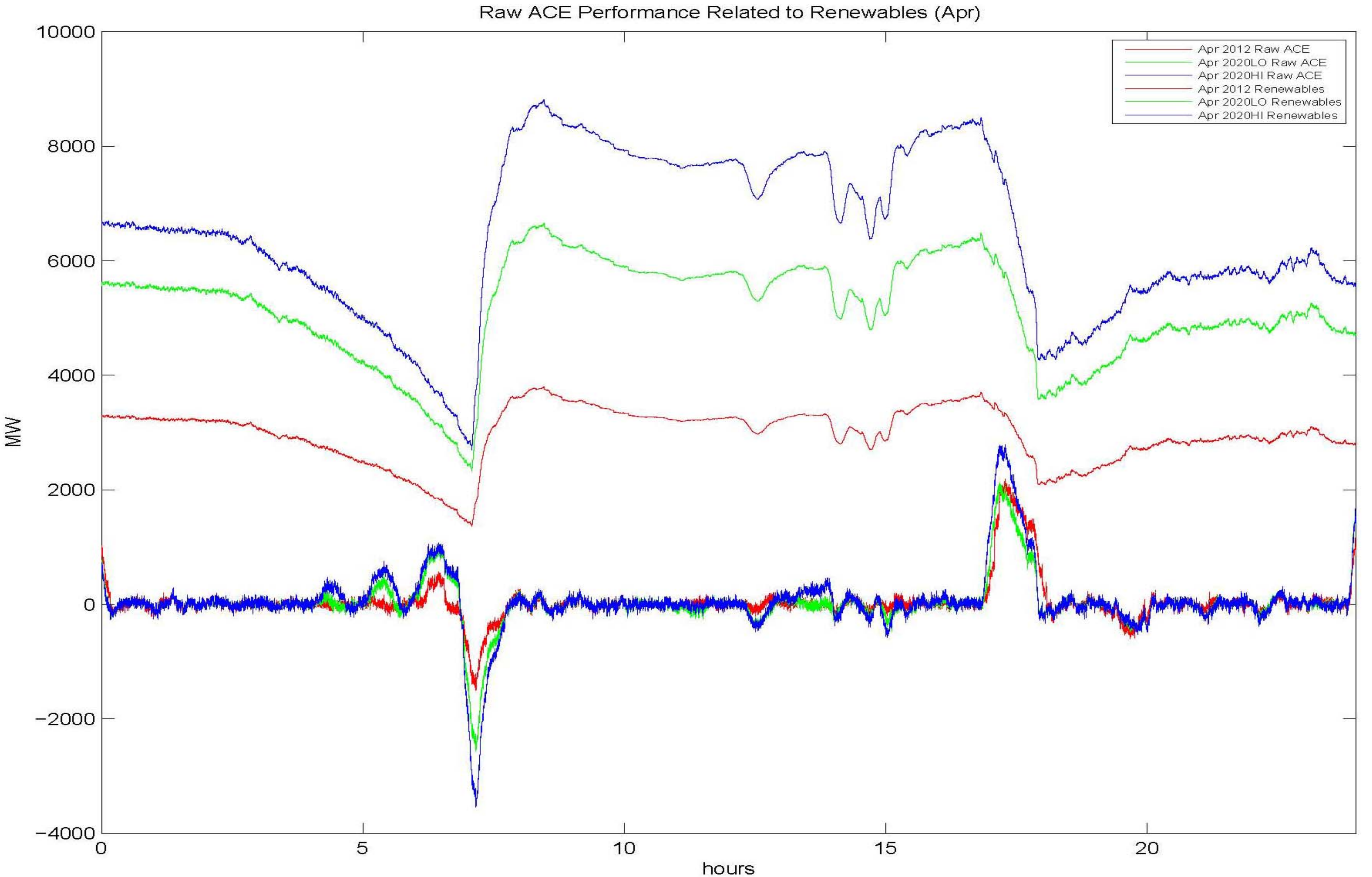
System Area Control Error (ACE)



4 Hr works

1 Hr does not work

April Day – ACE



Adjusting Conventional Generation Schedules for the 2012 and 2020 Cases

- Some conventional plants must be decommitted in hourly schedules
  - Each MW from renewables would mean 1MW less from conventional plants
  - Plan A: use results from CAISO/Nexant production costs study. (not available in study time frame)
  - Plan B: "Poor Man's Decommit"
    - Of the 250 plants modeled, we have ranked them by age and by type.
    - Plants are decommitted based on the priority list. ("Least efficient" units would go first.)
  - Some plants will be retired anyway. (per preliminary list of scheduled retirements)
  - Different cases / scenarios "re-commit" Combustion Turbines (or any other class of unit selectively) to provide ramping / regulation at specified level
  - New schedules "sanity checked" against scheduled imports, renewables, and load to ensure balance

Comment: Scheduling / De-commitment process is NOT for best economics but to study system dynamics; precise economics not a requirement for this study

KEMA

Major Conclusions

- System Requirements for "Normal" (non-ramping) periods
  - > 800 MW regulation in 2012
  - Approximately 1,600 MW in 2020
  - Storage more effective in smaller incremental amounts
- In the 2020 33% High Renewable Capacity Case the System may Require 3000 – 4000 MW of Regulation & Reserves
  - Even so, performance will not be acceptable by today's standards
  - Requires further investigation of renewable scheduling for certainty
  - System appears to have adequate ramping capability in CT & Hydro but wind / solar scheduling vs. conventional generation is a major difficulty
  - Performance will be sensitive to 15 – 30 minute errors in renewable forecasting
- 3000 MW / 6000MW of Storage will Suffice (except possibly for the April day studied)
  - Preserves current levels of performance with respect to ACE, Frequency, CPS1
- Storage Requires an Aggregate Ramping Capability of 0 – 100% in 5 minutes in the 33% scenario
  - May indicate limited effectiveness of pumped hydro and CAES

KEMA

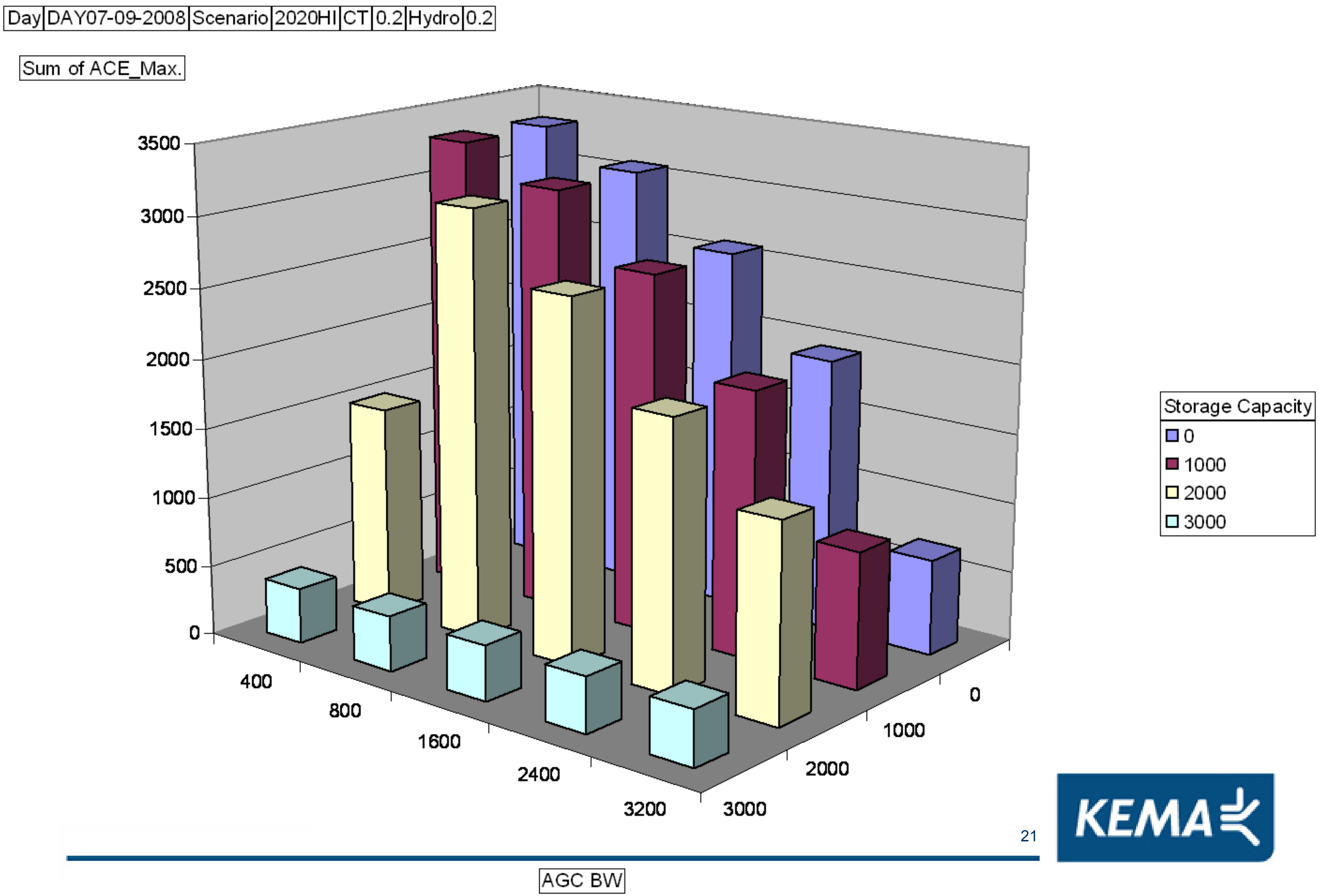
Major Conclusions (2)

- Storage equivalent to 110 MW Combustion Turbine appears to range between 30 – 50 MW of storage
  - Varies with other system conditions especially how much regulation is present
- Use of Combustion Turbines for increased regulation (forced commitment) increases overall system emissions by approximately 3% vs. using storage

System performance with storage and increased regulation during non-ramping hours

Scenario	Added Amount (MW)		Worst Maximum Area Control Error (MW)		Worst Frequency Deviation (Hz)		Worst Control Performance Standard 1 (percent)	
	Regulation	Storage	Regulation	Storage	Regulation	Storage	Regulation	Storage
20% RPS*	400	200	477	311	0.0470	0.0438	184	195
33% RPS* Low	800	400	480	493	0.0610	0.0609	190	190
33% RPS* High	1,600	1,200	480	344	0.0610	0.0590	191	196

ACE maximums for July 2020HI



Adding Storage for Normal Operations

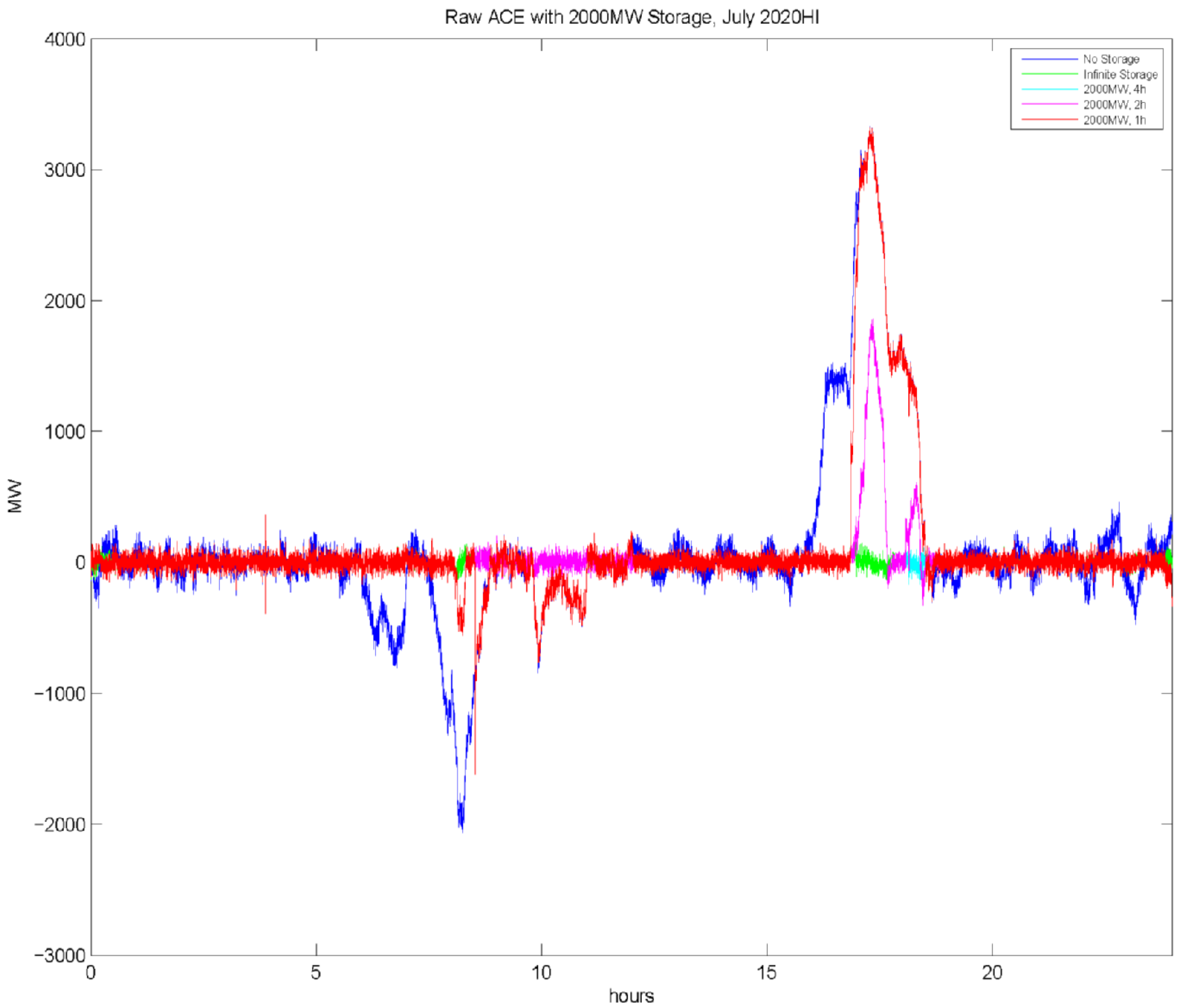
	Performance Across Regulation Levels With No Storage				Storage Added to 400 MW Regulation			
Year	Regulation	worst max ACE	worst dF	worst CPS1	Storage Added	worst max ACE	worst dF	worst CPS1
2012	400	477	0.047	184	200	311	0.0438	195
2012	800	325	0.0425	195				
2012	1600	316	0.0424	196				
2020 LO	400	690	0.063	173	400	493	0.0609	190
2020 LO	800	480	0.061	190				
2020 LO	1600	480	0.061	194				
2020LO	2400	480	0.061	194				
2020 HI	400	950	0.062	141	1200	344	0.059	196
2020 HI	800	662	0.061	172				
2020 HI	1600	480	0.061	191				
2020 HI	2400	382	0.061	191				
2020 HI	3200	382	0.061	191				

200 MW Storage > 400 MW Regulation

400 MW Storage = 400 MW Regulation

1200 MW Storage > 2400 MW Regulation

Evaluating Storage



2000 MW of storage with 4 hours of energy solves the problem.

2000 MW with 2 hours of energy helps

2000 MW of storage with only 1 Hr of energy does not control the ACE problem.

Policy Recommendations

- Use fast storage for regulation, balancing, and ramping either as a system resource to address aggregate system variability or as a resource used by renewable resource operators to address individual resource variability and ramping characteristics
- Procurement of increased regulation, balancing, and reserves by the California ISO
- Consider possible imposition of requirements on renewable resources to accommodate their effects on grid operation, such as ramp rate limits on renewable resources, more accurate short-term forecasting, sub-hourly scheduling, and other possibilities
- Pursue changes to the market system to encourage fast ramping by conventional generation resources
- Use demand response as a ramping/load following resource, not just a resource for hourly energy in the day-ahead market or for emergencies

Study Strengths & Weaknesses

Strengths:

- Detailed High Fidelity System Dynamic Model
- Calibration to CA ISO Data
- Ability to investigate the interaction of renewables, scheduling, dispatch, regulation, droop
- Development of algorithms for renewables and storage integration
- Runs 24 Hrs in approx 15 minutes
- Extensive post processing analysis capabilities

Weaknesses:

- Only a few representative days studied
- Real Time Dispatch / Balancing was old BEEP rather than MRTU
  - Some look-ahead embedded
- Conventional Unit response capabilities "optimistic"
  - Follow dispatch at rate limit promptly; regulation through full range
- "Perfect" Renewables Forecasts
- Concentrating Thermal Solar data based on two existing plants

Goal – Understand Renewables' Impact on Grid Operations

- Understand variability and volatility of Renewables – esp CST and PV
- Understand characteristics and potential of ADR
- How to forecast better – day ahead, hour ahead, intra hour
- How to factor renewable variability/volatility in dispatch and how to use storage and ADR
- What resource capabilities (storage, ADR) are needed to manage renewables
- How to distribute volatility management across time frames and products
- Understand Requirements of AGC to manage Renewables and Use ADR and Storage
- Develop and test AGC Algorithms
- What monitoring, command, and control over new resources is required?
- Understand requirements of AGC to manage Renewables and use ADR and storage
- Develop and test AGC algorithms
- What monitoring, command, and control over new resources is required?

What are Priorities for Future Work?

Develop dynamic models of CST and CSP / utility scale PV

Develop statistical description of variability with temporal and spatial correlations

Develop consensus forecast

Develop models of distributed PV and ADR for use in load disaggregation

Incorporate Renewable Variability, Storage characterizations, and ADR characteristics in Day Ahead Scheduling and Real Time Dispatch

Develop realistic scenarios of conventional unit performance for simulation

Integrate ADR, updated renewables and storage models

Install KERMIT at CA ISO and deliver training

Develop AGC Algorithms and Test

Identify “scenarios” for future portfolio and use in 2012 and 2020 studies

Integrate production cost / market simulations as inputs to KERMIT

Use KERMIT to iterate with production and market simulations around ancillaries requirements

Study impacts of forecasting accuracies

Conclusions

- Frequency Responsive Load (or Storage /Autonomous DR) is of benefit
  - Will be of greatest benefit in an island situation
- Using fast resources in response to ACE is better than response to frequency (assuming similar time constants and control/ communications) especially in terms of controlling tie flows resulting from generation/load imbalance
- Best choice of control will depend upon the situation and the problem being addressed
  - Autonomous frequency response has the virtue of requiring no control / communications

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Energy Storage Overview

SCE's Approach to Energy Storage

Executive Summary

- SCE's long-standing interest in energy storage continues today through engineering pilots and a comprehensive strategic planning effort.
- SCE approaches energy storage from the perspective of system needs and potential storage applications, and not technology capabilities.
- Energy storage is a broad and heterogeneous category, made up of numerous distinct operational uses and technologies.
- A primary challenge facing energy storage is to develop and evaluate **specific** and **practical** applications. Costs and benefits are situation-dependent, and will vary based on the nuances of each particular project.

SCE'S Approach To Energy Storage

Engineering Pilots and Demonstration Efforts

- ***Chino Battery Storage Project*** (1988-1996): demonstrated a 10 MW / 40 MWh lead acid battery
- ***Electric Vehicle Technical Center*** has tested a wide variety of battery chemistries, modules, and management systems since 1993 in a nationally recognized and certified research center
- ***Tehachapi Storage Project ****
- ***Irvine Smart Grid Demonstration ****

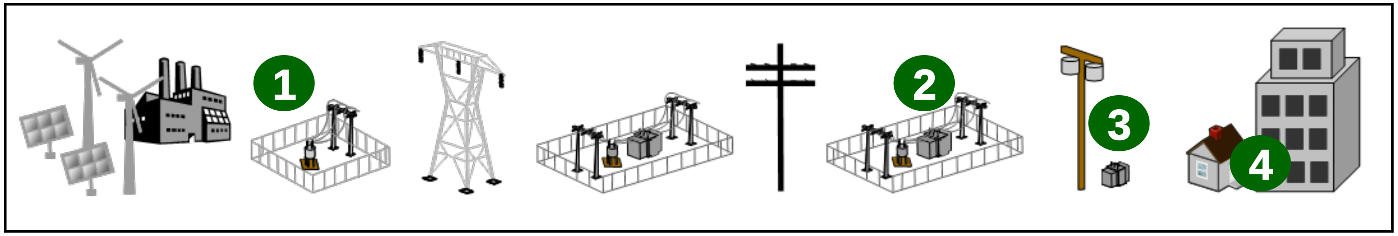
SCE has approached energy storage from two angles

Strategic Planning

- Deepen SCE's understanding on energy storage technologies
- Define potential energy storage applications to communicate preferred specifications internally and externally
- Engage energy storage stakeholders and regulatory agencies in key policy issues
- Create a strategic "roadmap" for SCE's future engagement with energy storage

** See next slide and appendix for more detail*

SCE's Current Primary Storage R&D Efforts



Tehachapi Storage Project

1. Large-Scale Battery Storage (8MW for 4 hours or 32MWh)
   - Evaluate a utility scale lithium-ion battery's ability to increase grid performance & integrate wind generation

Irvine Smart Grid Demonstration

2. Large Transportable Battery System (Two 2MW/500kWh units)
   - Evaluate transportable, containerized Li-ion battery systems in field and laboratory trials
3. Community Energy Storage (Distributed units: 25kW/50kWh)
   - Enhance circuit efficiency, resilience, and reliability
4. Residential Home Energy Storage (4kW/10kWh)
   - Evaluate home storage integration with customer HAN, EE, smart appliances, solar PV, PEV, etc.

See appendix for further details

Needs and Policy Goals Drive Solutions

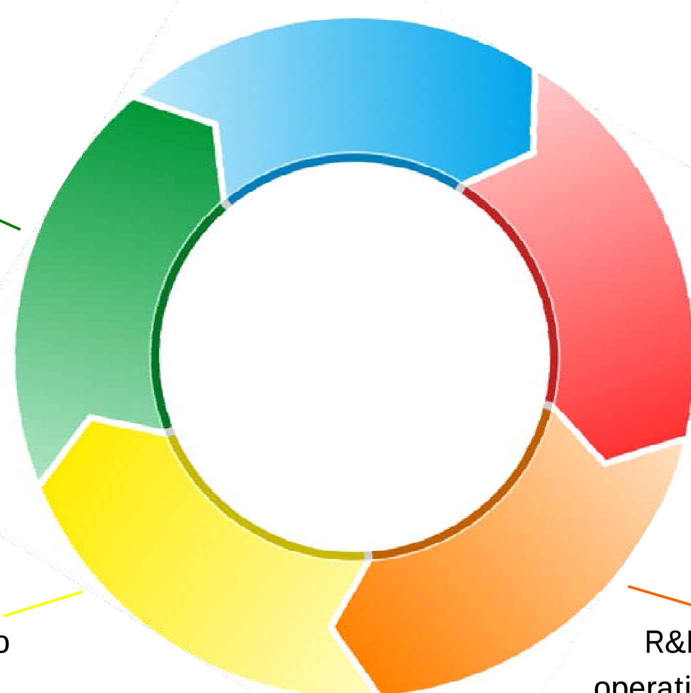
System needs and clear regulatory and policy goals can frame the opportunities for storage or other solutions.

Define Objectives

System needs and policy goals highlight challenges in need of solutions.

Identify Potential Solutions

Industry/others identify potential solutions, e.g., storage. These solutions come with operational and technical uncertainties.



Test Proposed Solutions

R&D assesses technological potential, operational feasibility, and economic viability.

Communicate Findings

Results must be communicated back to stakeholders to inform next steps.

Stakeholders consider results and compare alternative solutions.

SCE's Methodology For Assessing Energy Storage

Step 1:	Step 2:	Step 3:	Step 4:
Identify operational uses & understand technologies	**Develop practical applications**	**Match applications with technologies**	**Evaluate applications**

Step 1: Identify operational uses & understand technologies

- Document the **discrete, individual uses of energy storage** along the electricity value chain from central generation to end user
- Assess technologies & their commercial viability

Step 2: Develop practical applications

- Combine operational uses into **practical applications**
- Applications are specific to SCE's system and market structure

Step 3: Match applications with technologies

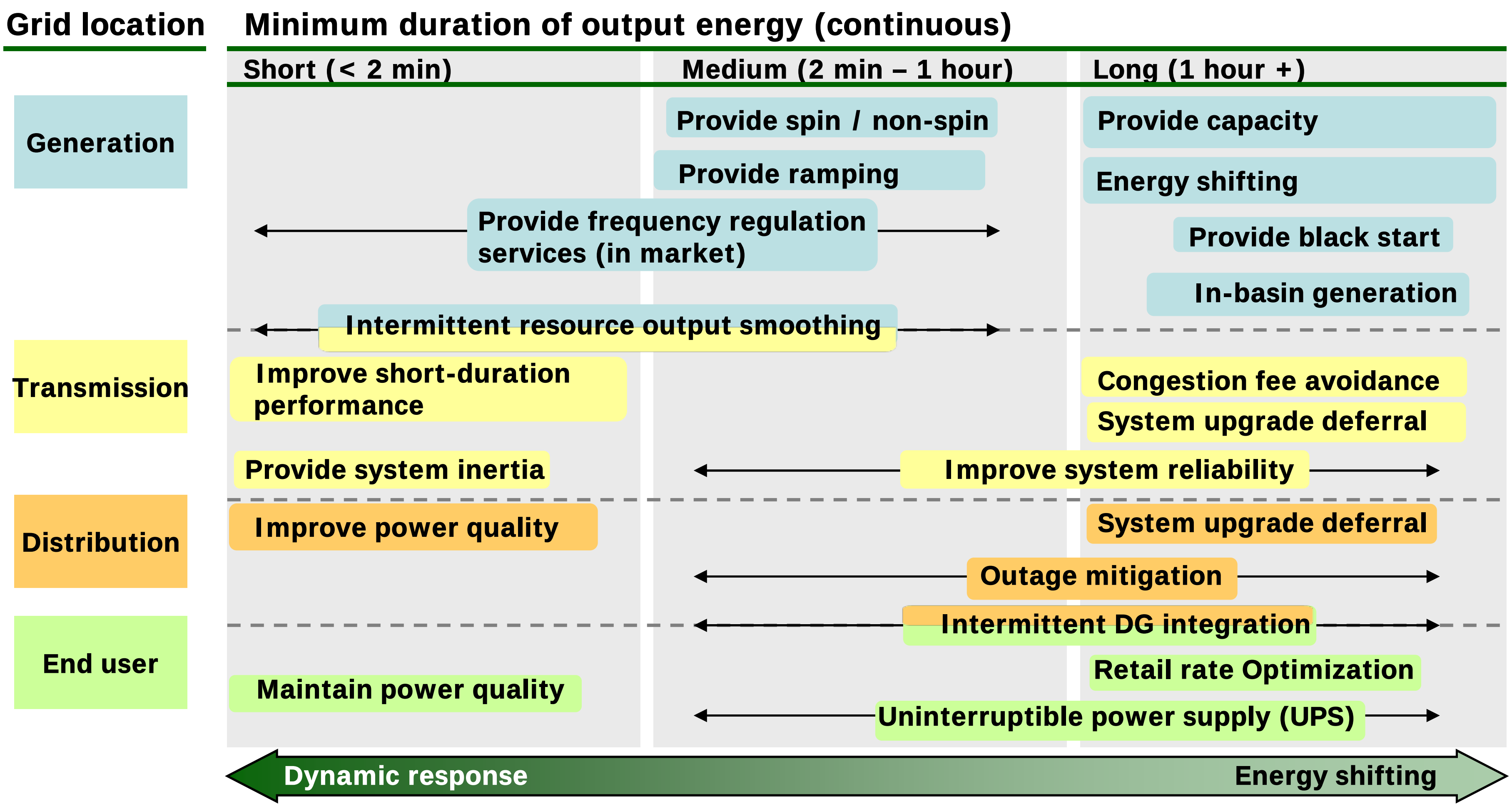
- Define **primary application requirements** and preferences
- Identify & **assess "best fit" technologies**

Step 4: Evaluate applications

- Apply **cost / benefit analysis** to specific application & technology pairs
- Approach from both the **current environment** and **expected future** circumstances

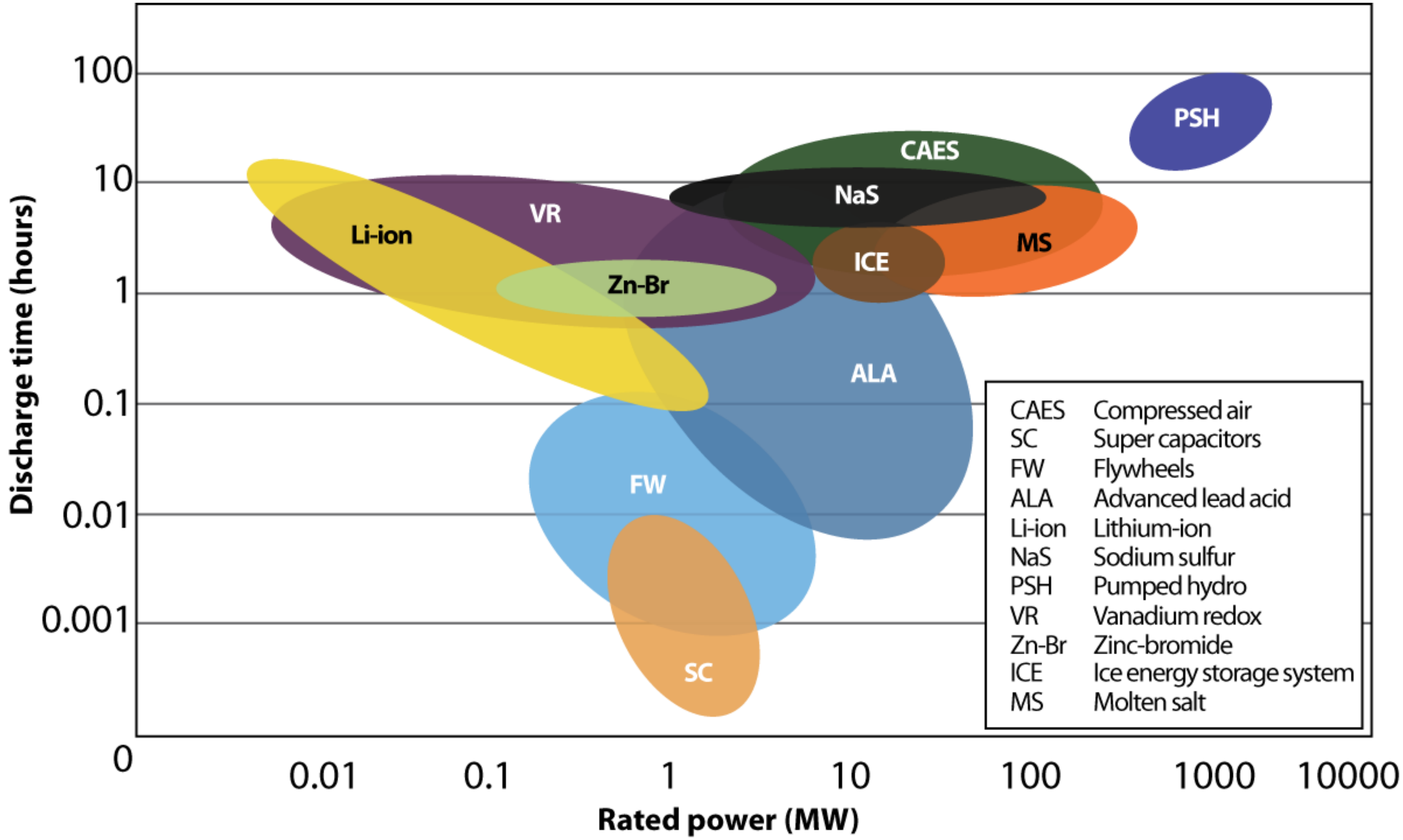
SCE approaches energy storage from the perspective of potential applications, and not technology capabilities

Potential Operational Uses For Storage Systems



Energy storage could provide a variety of operational uses ("benefits") throughout the electric value chain

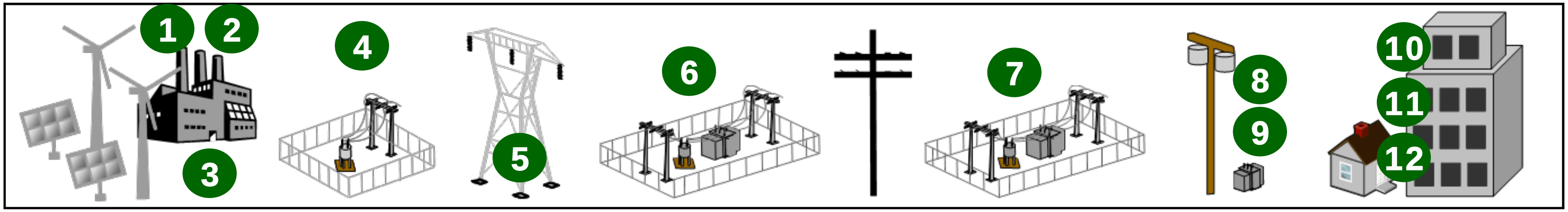
Technology Overview



Energy storage is a broad and heterogeneous category made up of many different technologies with a wide range of operational characteristics.

A technology's rated power and discharge duration help to define potential matching applications.

Developing Practical Storage Applications



EXAMPLES

1 Off-to-on peak intermittent energy firming for generator	Charge device at the site of off-peak renewable and/or intermittent energy sources – discharge "firmed and smoothed" energy onto grid during on-peak periods
8 "Peak shaving" downstream of the distribution system	Charge device off-peak downstream of the distribution system – discharge during 2-4 hour peak period daily
10 End user rate optimization	Charge device "behind the meter" when retail TOU prices are low – discharge when high (or during DR curtailment periods)

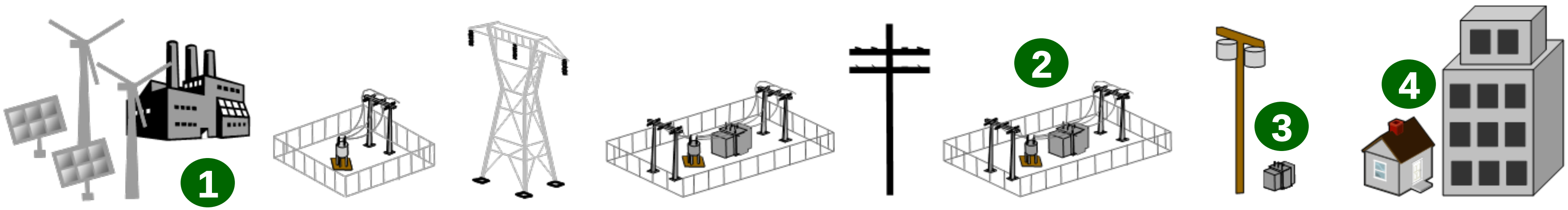
SCE has defined and evaluated twelve representative practical applications for energy storage by combining operational uses at specific locations on the grid

Conclusions

- Valuing energy storage requires a consistent methodology:
  - Developing specific and practical applications which potentially aggregate operational uses across the electric value chain
  - Identifying "best fit" technologies for each application
  - Evaluating specific application-technology pairs under both current and future circumstances
- Much work remains:
  - Testing/demonstrating the operational viability of storage on our grid
  - Calculating detailed monetary benefits of the various storage applications
  - Addressing the regulatory issues associated with energy storage

Appendix

SCE's Current Primary Storage R&D Efforts



1 Large-Scale Battery Storage	
Name	Tehachapi Storage Project (TSP)
Objective	Evaluate a utility scale lithium-ion battery's ability to increase grid performance & integrate wind generation
Size	8 MW for 4 hours or 32 MWh
Cost	$53.5 million ~50% ARRA
Timeline	2010-2014

2 Large Transportable Battery System	
Name	Distributed Generation Storage Services Evaluation
Objective	Evaluate transportable, containerized Li-Ion battery systems in field & laboratory trials
Size	Two 2 MW / 500 kWh units
Cost	~ $3 million Part of ISGD* (sub-project 3)
Timeline	2010-2013

3 Community Energy Storage	
Name	Community Energy Storage System Research
Objective	Enhance circuit efficiency, resilience and reliability
Size	Distributed units (25kW / 50kWh)
Cost	Part of ISGD* (sub-project 4)
Timeline	2011-2013

4 Residential Home Energy Storage	
Name	Home Battery Pilot (HBP)
Objective	Evaluate home storage integration with customer HAN, EE, smart appliances, solar PV, PEV, etc.
Size	4kW / 10 kWh
Cost	~ $3 million Part of ISGD* (sub-project 1)
Timeline	2010-2013

** Irvine SmartGrid Demonstration: $80.2 million project ~ 50% ARRA funded*

Application Example:

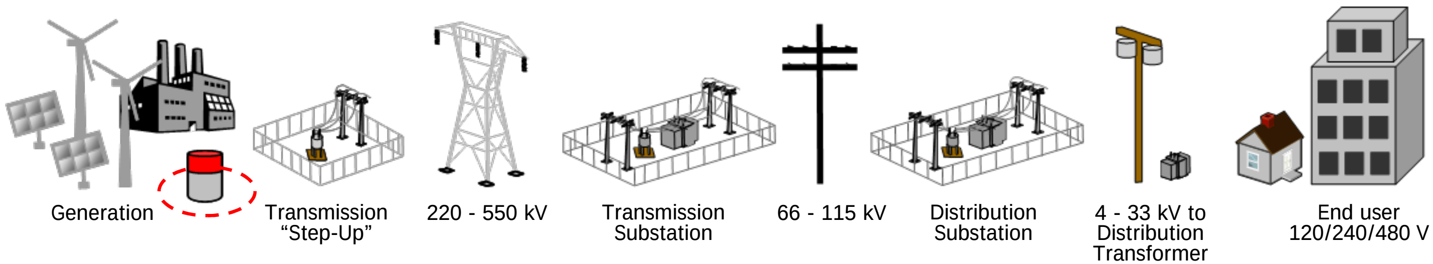
EXAMPLE

Off-to-on peak intermittent energy shifting & firming at or near generation

Application description

Charge at the site of off-peak renewable and/or intermittent energy sources (storage device should be sized to absorb several hours of energy); discharge "firmed" energy to grid during on-peak periods.

Physical Location on Grid



	Operational use ("benefits")	**Potential value metric**	**Comments**
Primary Drivers and Definite Operational Uses	Resource Adequacy / dependable operating capacity	Peak capacity avoided cost	Valuation is roughly modeled from the cost of a new peaking unit
	Intermittent energy firming	Specific renewable integration costs attributed to firming off-peak energy	Avoided integration cost of firmed on-peak gen instead of intermittent off-peak
	Wholesale price energy shifting (arbitrage)	Price differential between charge and discharge less efficiency losses	On-off peak spreads decrease with increasing penetrations of storage
	Intermittent energy smoothing	Specific renewable integration costs attributed to off-peak energy smoothing	This integration cost varies by technology and grid/portfolio circumstance, but may include avoided A/S procurement
Potential Other Operational Uses	Avoid dump energy / minimum load issues	Price differential between charge and discharge less efficiency losses	Value only if and when operational and/or economic over gen situations occur
	Transmission short duration performance improvement (voltage, frequency, fault duty)	Avoided cost of deferred/replaced infrastructure	But for storage, what costs would be incurred on the T system (if any) to counteract short-duration issues
	Transmission system reliability (longer-duration outages)	Avoided cost of deferred/replaced infrastructure	But for storage, what costs would be incurred on the T system (if any) to counteract long-duration issues
	Transmission fee avoidance	Transmission fees avoided	But for storage, what would have been paid for un-utilized reserved transmission

Tehachapi Energy Storage Project (TSP)

- **Objective**
  - Evaluate utility scale lithium-ion battery technology in improving grid performance and integrating wind generation.

- **Project Specifics**
  - **Size:** The project team will design and build an 8 MW – 4 hour (32 MWh) lithium-ion battery system and smart inverter, and connect it to SCE's Monolith substation near the Tehachapi Wind Resource Area (TWRA). SCE and the project participants will baseline the project by collecting data about the Antelope-Bailey 66kV system using existing and new measurement equipment.
  - **Cost:** $53.5 million, with SCE and partners providing $27.5 million, CEC match of $1 million with $25 million in matching funds from the Department of Energy.
  - **Team:** California Independent System Operator (CAISO) and A123 Systems as project participants, while Quanta Technology and California State Polytechnic University, Pomona will provide engineering support, measurement and reporting services.

- **Expected Results**
  - This project will demonstrate the ability of lithium-ion energy storage to enhance grid operations and wind power integration by measuring performance under 13 specific operational uses. These functions will help achieve the Department of Energy's (DOE) stated goals in this Funding Opportunity Announcement of utility load shifting, increasing the dispatchability of wind generation, and enhancing ramp rate control to minimize the need for fossil fuel-powered back-up generator operation. SCE also intends to use this demonstration project to advance core battery technology for use throughout the electric energy industry.

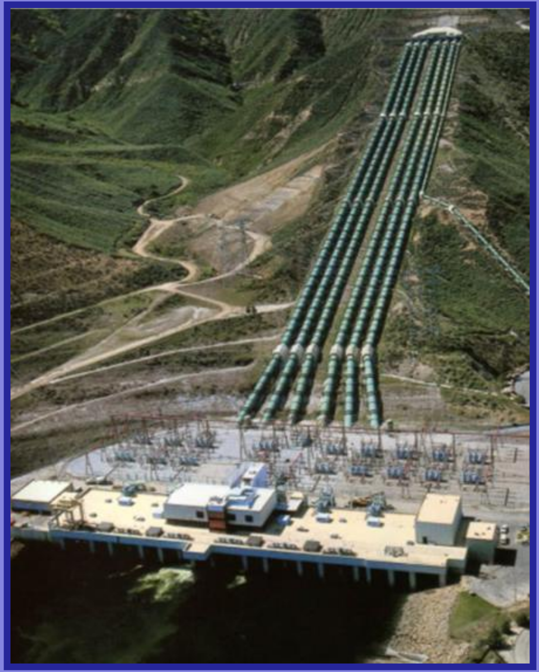
Irvine Smart Grid Demonstration (ISGD)

- **Objective**
  - The ISGD project will allow SCE, its partners and the DOE to verify, quantify, and validate the feasibility of integrating Smart Grid technologies. The ISGD project will verify the viability of Smart Grid energy technologies and cyber security when deployed in an integrated framework. Further, it will provide a means to quantify the costs and benefits of Smart Grid technologies in terms of overall energy consumption, operational efficiencies, and societal/environmental benefits. Finally, the ISGD project will allow SCE, its partners and the DOE to test and validate the scalability of tested Smart Grid elements including customer energy storage applications.

- **Project Specifics**
  - SCE's ISGD project starts with CAISO operator deep distribution situational awareness using phasor measurement and then extends beyond the substation to evaluate the latest generation of distribution automation, including: universal remote circuit interrupters (URCI), looped 12 kV distribution circuit topology, and advanced voltage control sensing and self-healing technologies. The ISGD scope continues into the home, by demonstrating the integration, monitoring, control and efficacy of the home area network (HAN) and consumer devices such as smart appliances, electric vehicles, energy storage and photovoltaic solar generation. Tying all this together is the Secure Energy Network (SENet) which will enable end-to-end interoperability and cyber security.
  - **Cost:** Total project cost is $80.2 million, with SCE and partners providing $39.1 million, CEC match of $1 million and seeking $40.1 million in match from the Department of Energy.
  - **Team:** Boeing, General Electric, SunPower Corporation, Electric Power Research Institute (EPRI), ITRON, University of Southern California Information Sciences Institute, California State Polytechnic University at Pomona, and University of California at Irvine.

- **Expected Results**
  - This project will demonstrate a scalable model of a Smart Grid System that can be used to validate the interoperability of emerging NIST and NERC standards for future Smart Grid systems and applications, including standards for implementation, integration, communications, cyber-security and interoperability. This project will also produce measured results on all benefits as outlined by the DOE in Appendix A of the FOA, and will help provide a blueprint to build the Smart Grid workforce of the future.

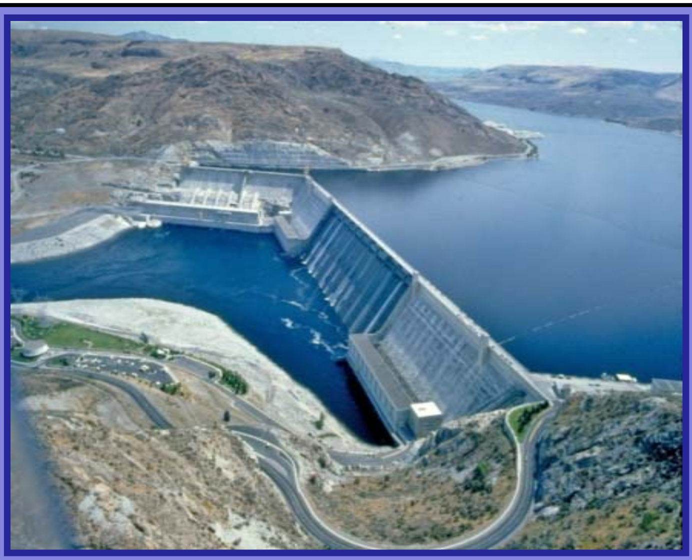
- The Use of Large Scale Pumped Hydro -
Energy Storage for Grid Reliability, Renewable Integration and Renewable Load Shifting



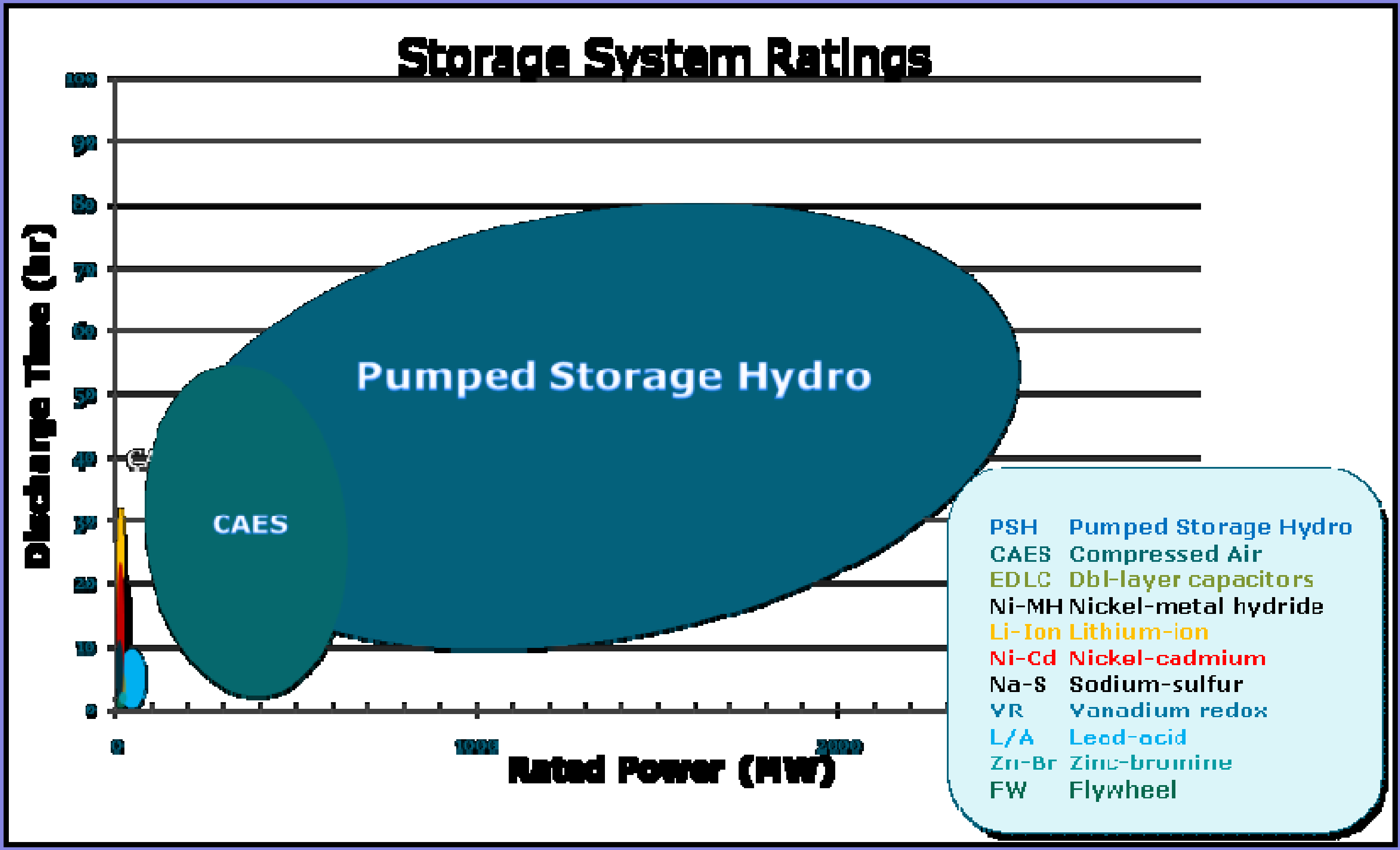
IEPR Staff Workshop
Technologies to Support Renewable Integration
(Energy Storage and Automated Demand Response)
November 16, 2010

Pumped Storage Hydropower's Role in Grid Scale Energy Storage

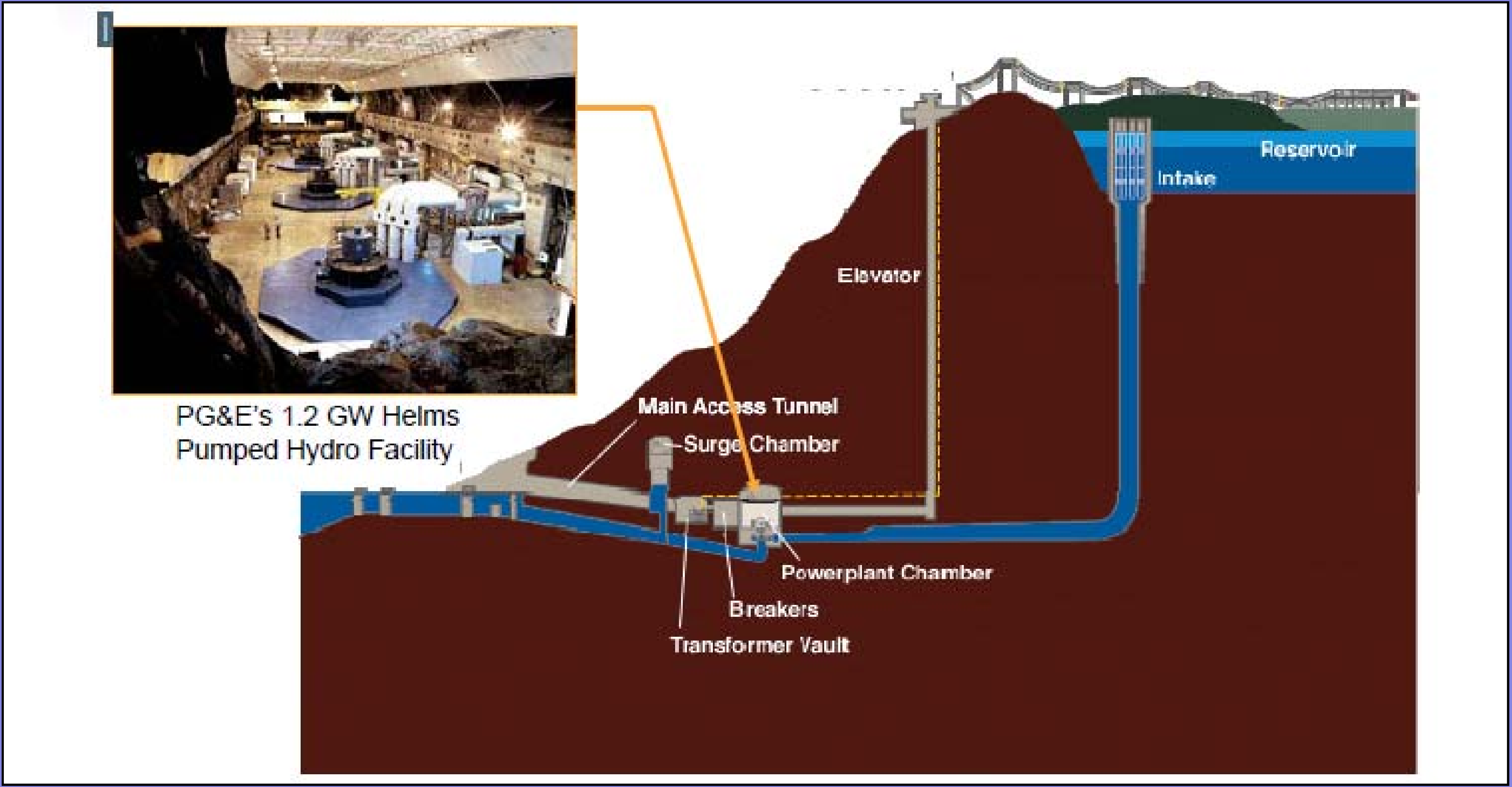
- Grid scale storage enables development of double digit levels of wind penetration.
- Europe integrates variable energy with big transmission, conventional hydro and carbon free pumped storage.
- Changing US and California market for system reserves and grid reliability services.



Energy Storage Technologies

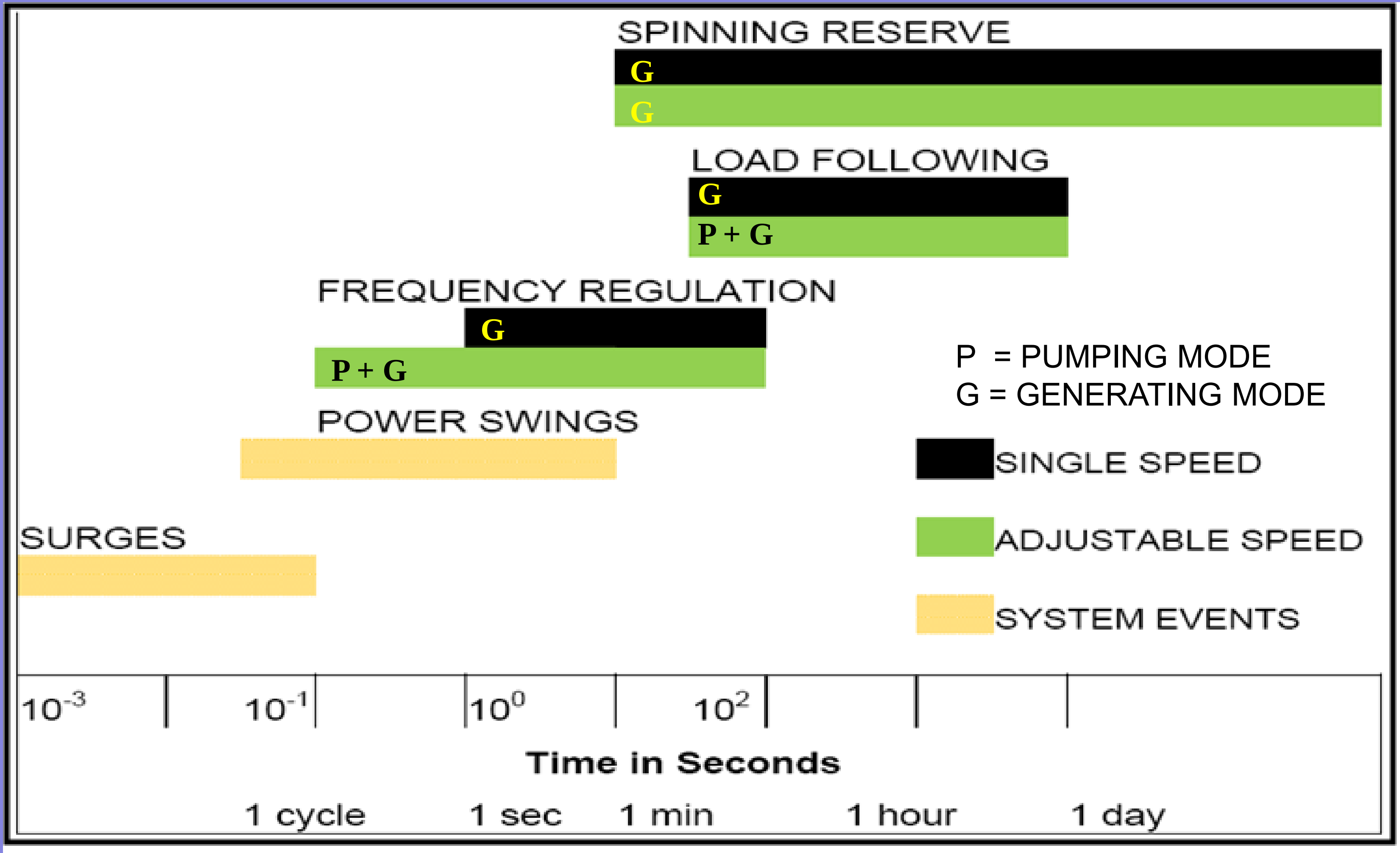


How Pumped Storage Works



Typical Pumped Storage Project Design Scheme

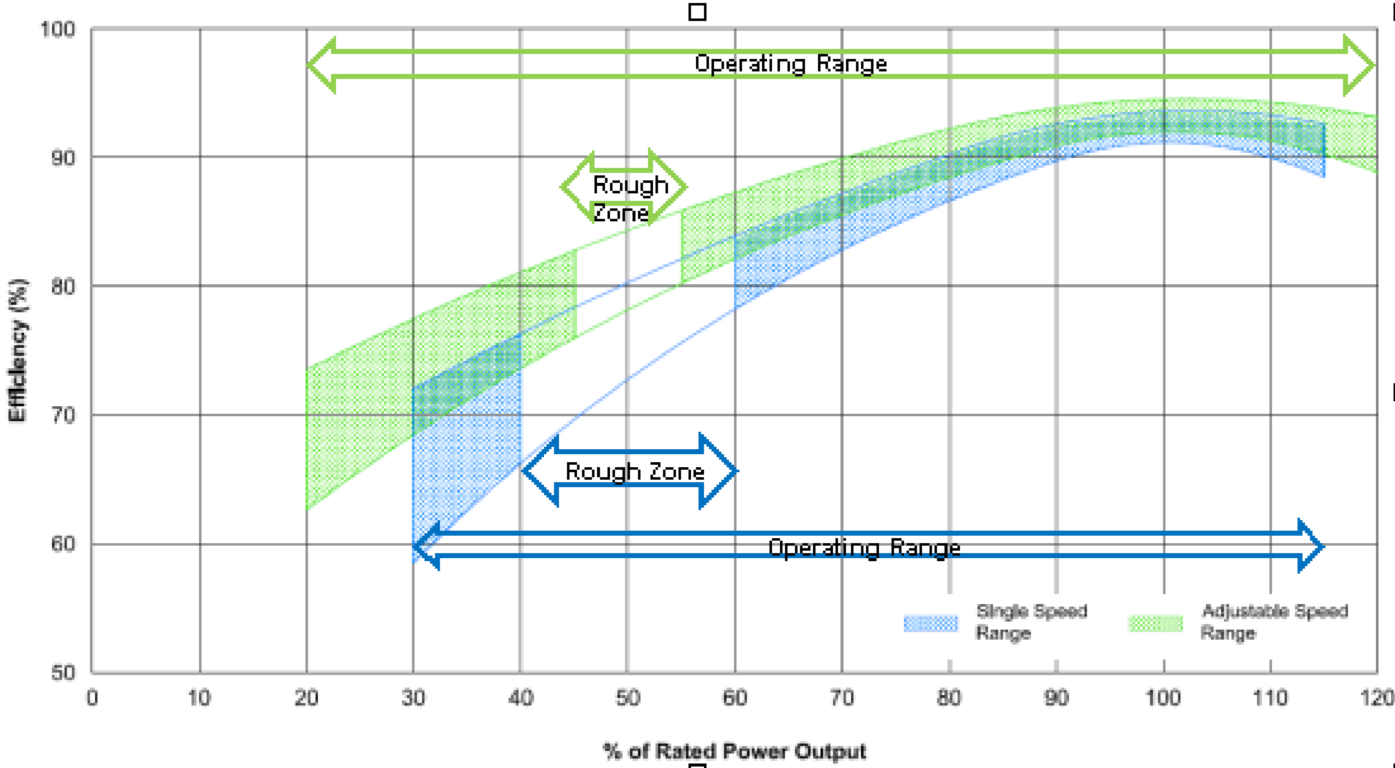
Adjustable Speed Pumped Storage Fast Response Capabilities



Adjustable Speed vs Single Speed

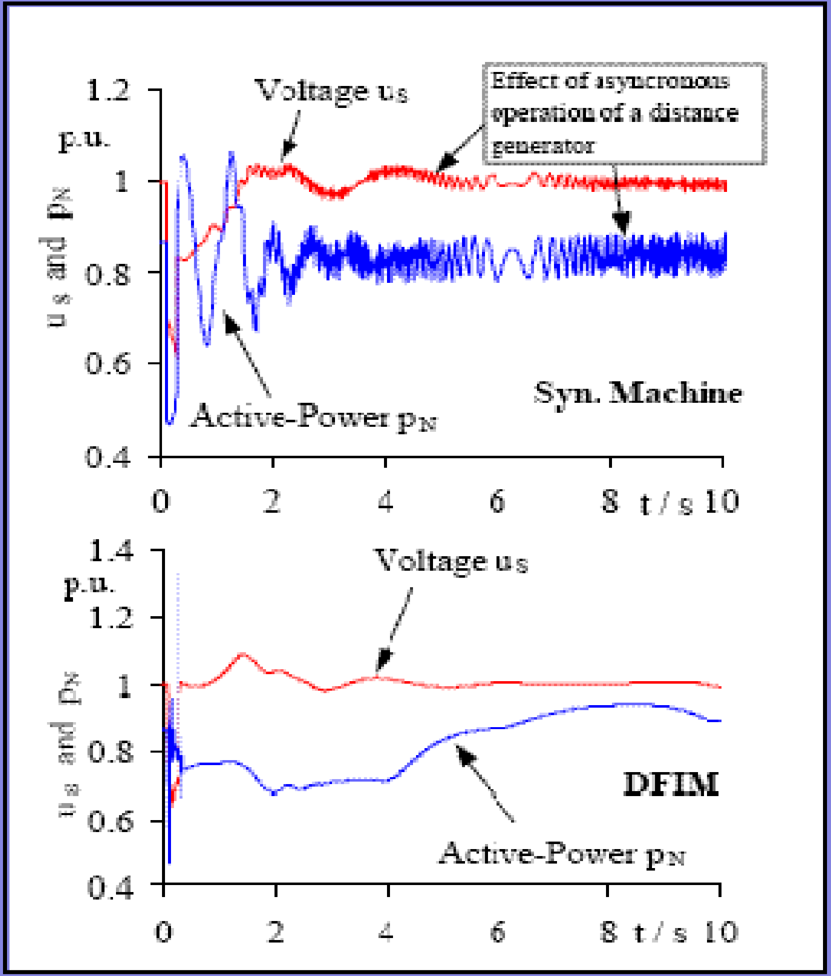
- Expanded operating range
- Higher Efficiency
- Additional Output

Actual Ex:
A 395 MVA PSH unit with ASH capability expands its operating range from 140 MW to 204 MW

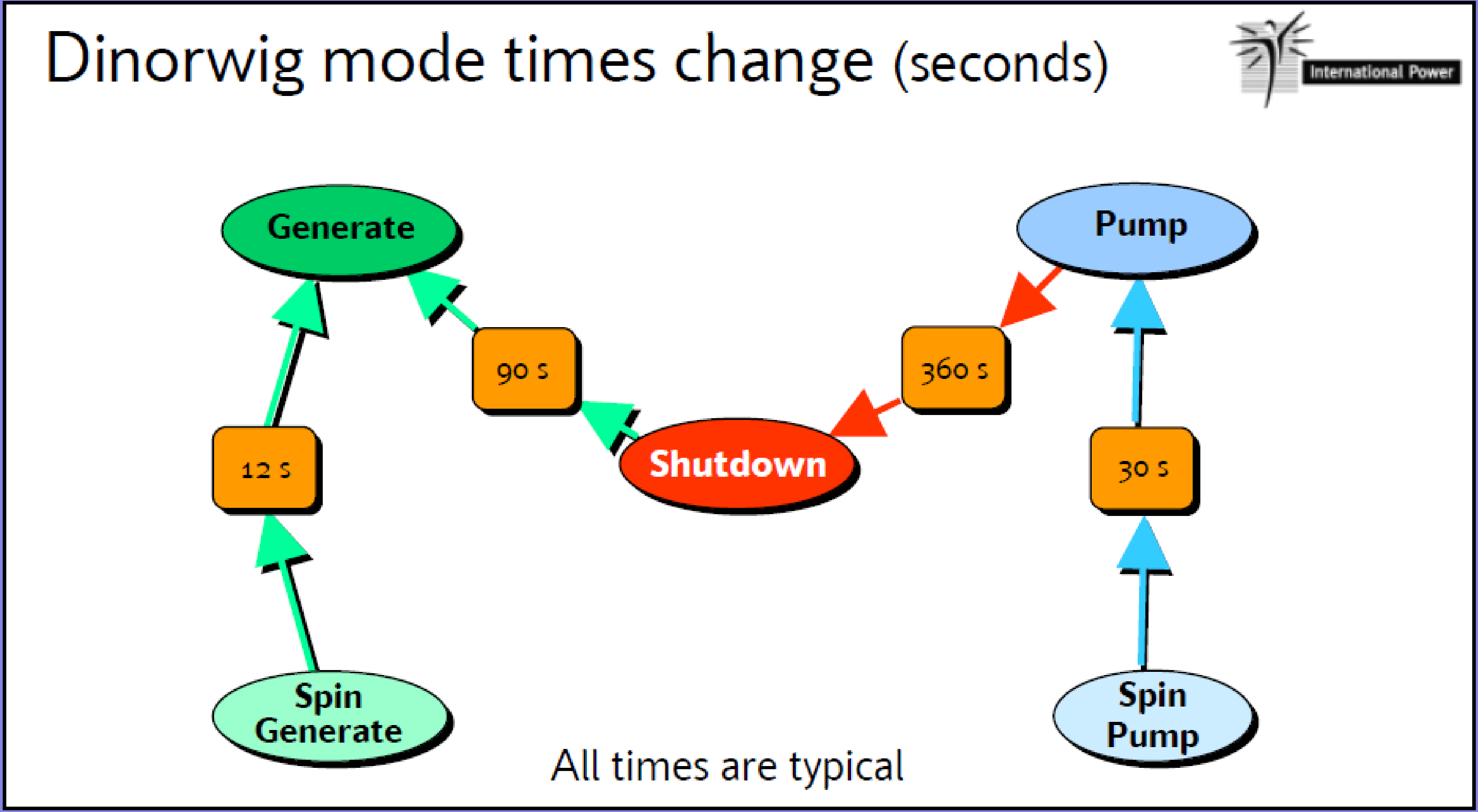


Adjustable Speed Pumped Storage is a 'fly wheel'

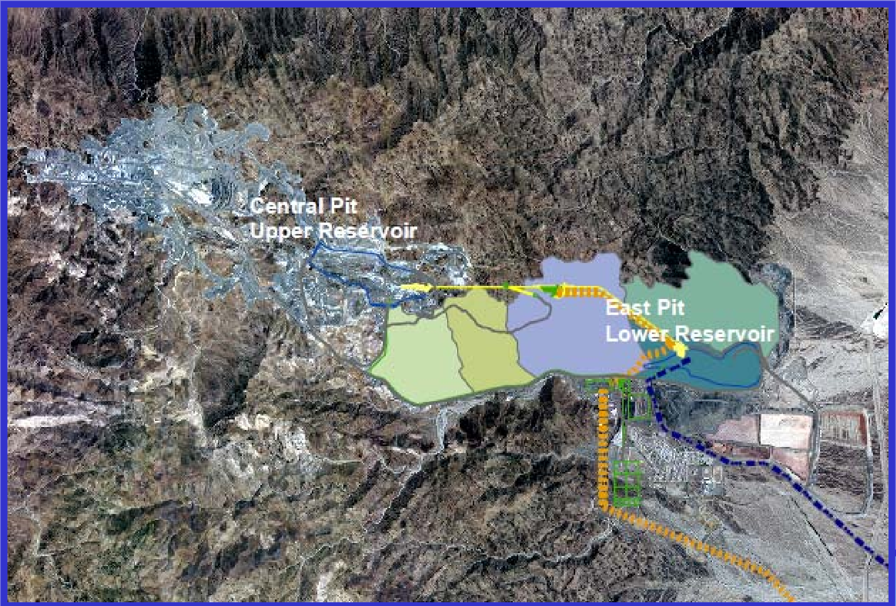
- Utilize angular momentum stored in spinning rotor mass.
- Rapid change of rotor speed
- ≈ 150 Milli Seconds
- Change speed and energy stored in rotating inertia: $\omega M = \omega S \pm \omega R$
- Control bulk power system power and frequency variations.



- Pump-Generating Turbine Capabilities - Turn Around Times (Pump to Generate)



Benefits of Closed Loop Pumped Storage System

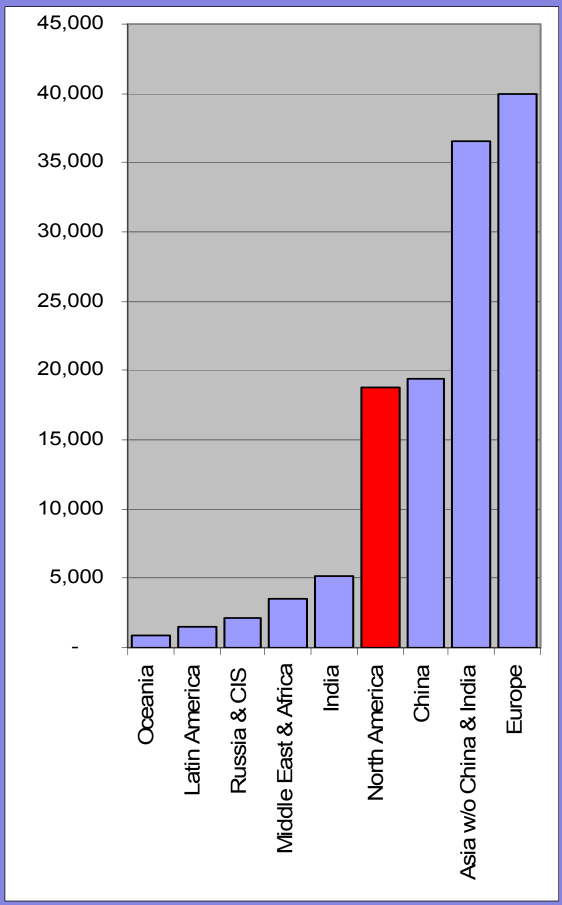


- Self contained "off-stream" water system
- No need for new dams on main stem rivers
- Uses existing infrastructure
- Minimizes environmental impacts (shorter permitting time)

Snapshot of Pumped Storage Globally

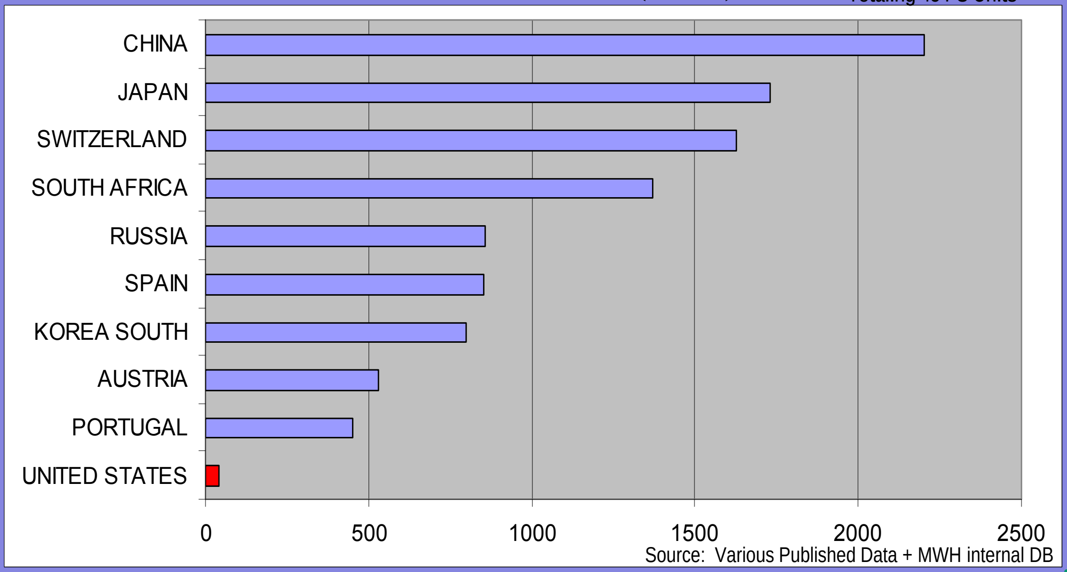
Pump Storage Units in Operation (MW) by Country/Continent

- 127,961MW Worldwide
- Totaling 922 PS Units



Pumped Storage Projects Under Construction (MW)

- 10,453 MW Worldwide
- Totaling 45 PS Units



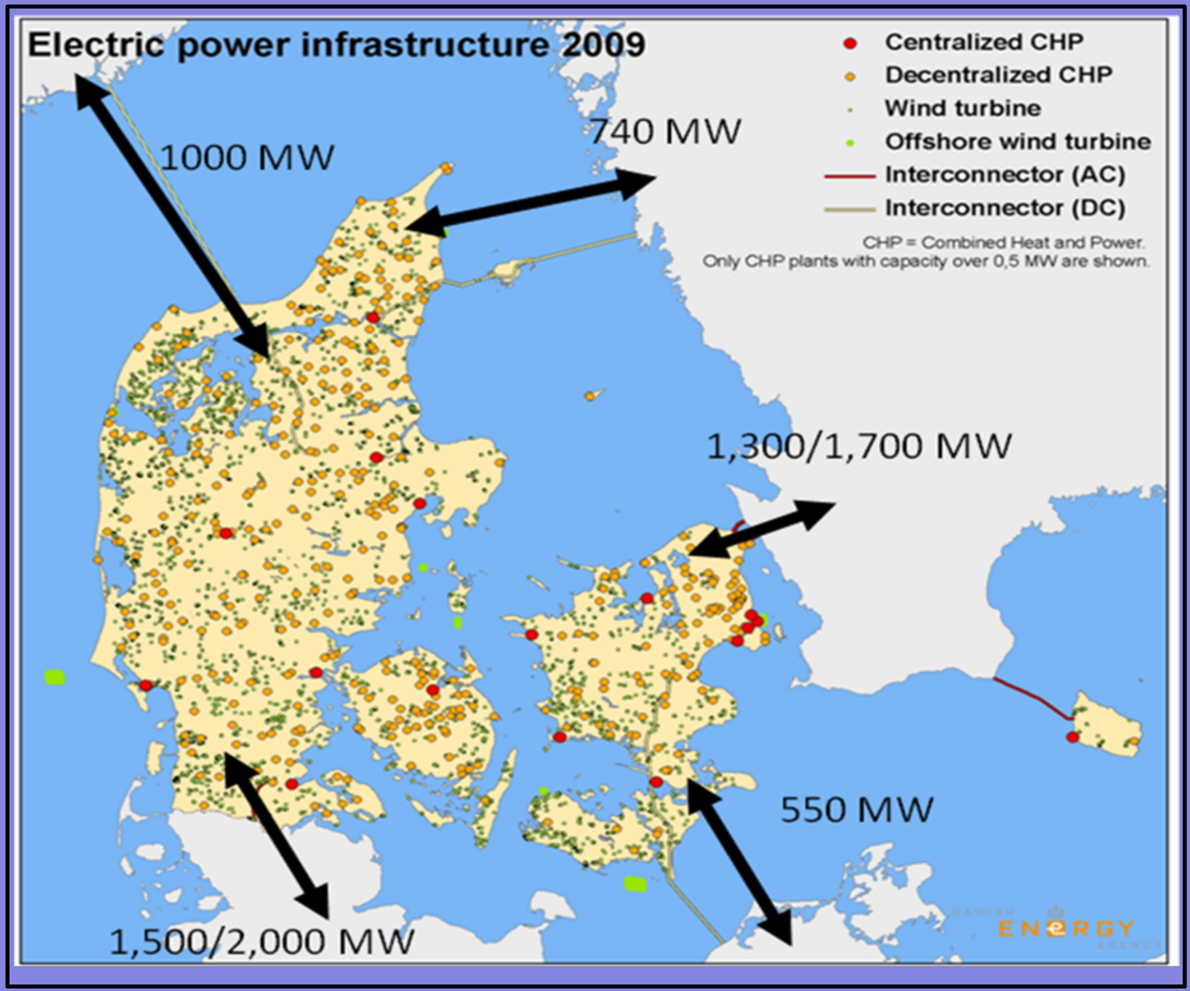
Pumped Storage Trends in Europe

- Most economical means of Energy Storage
  - A fundamental grid component
- Provides balancing, reserves and grid stability for new interconnected ISOs
- Proven reliable technology with 50 to 100 year design life
- Large increase in Wind Energy to 8% of Energy (53GW) – with selected regions > 20% penetration
- Adjustable/Variable speed focus new and re-optimization of existing plants
- European approach toward pumped storage is spreading globally

Denmark & Grid Reliability

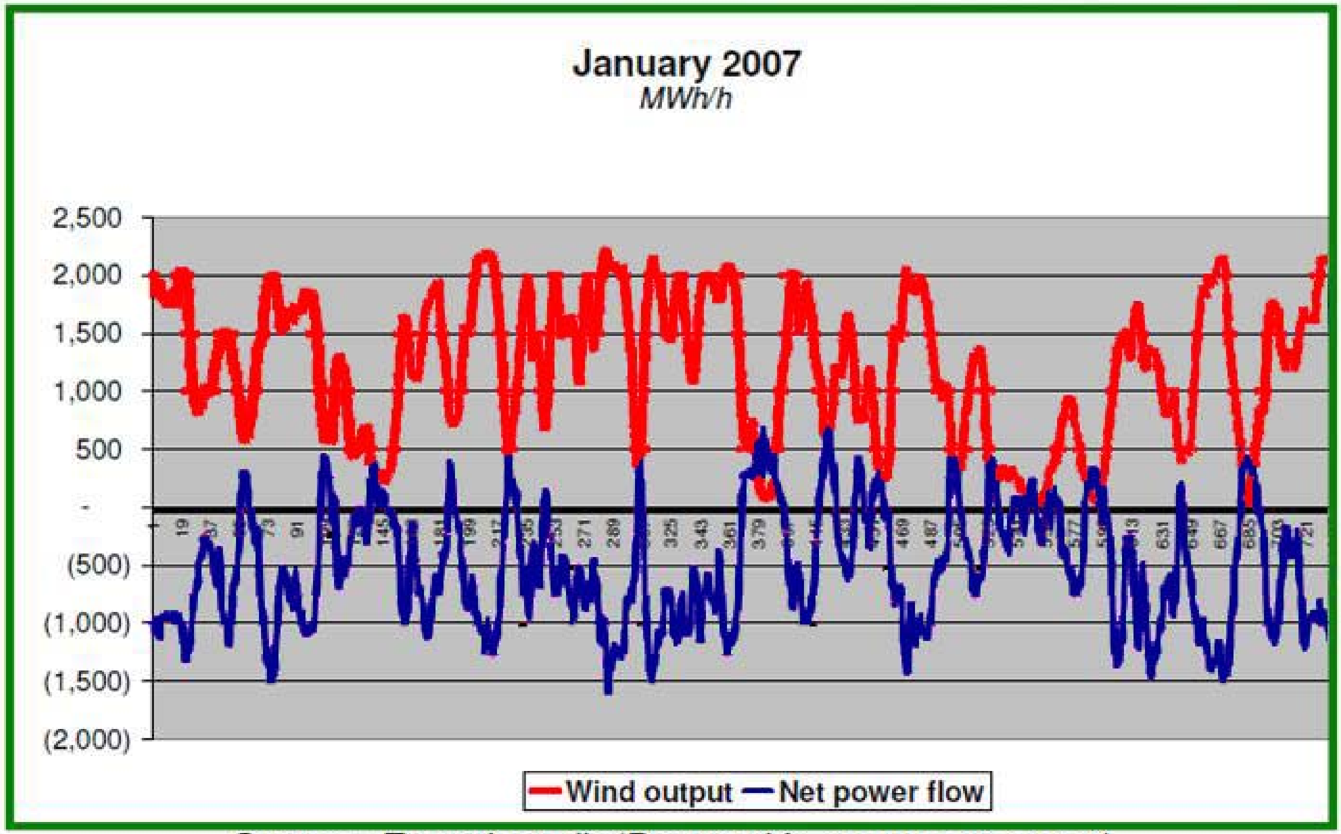
- 30% wind penetration in the generation mix
- No native load balancing
- Balancing services provided via interconnects
  - Strong interconnections with Norway , Sweden and Germany
  - Utilizes energy storage and flexible energy options in neighboring balancing areas
  - Excess wind is exported and stored in Norwegian hydropower reservoirs

Power Balance in Denmark 2008



Source: Energinet.dk

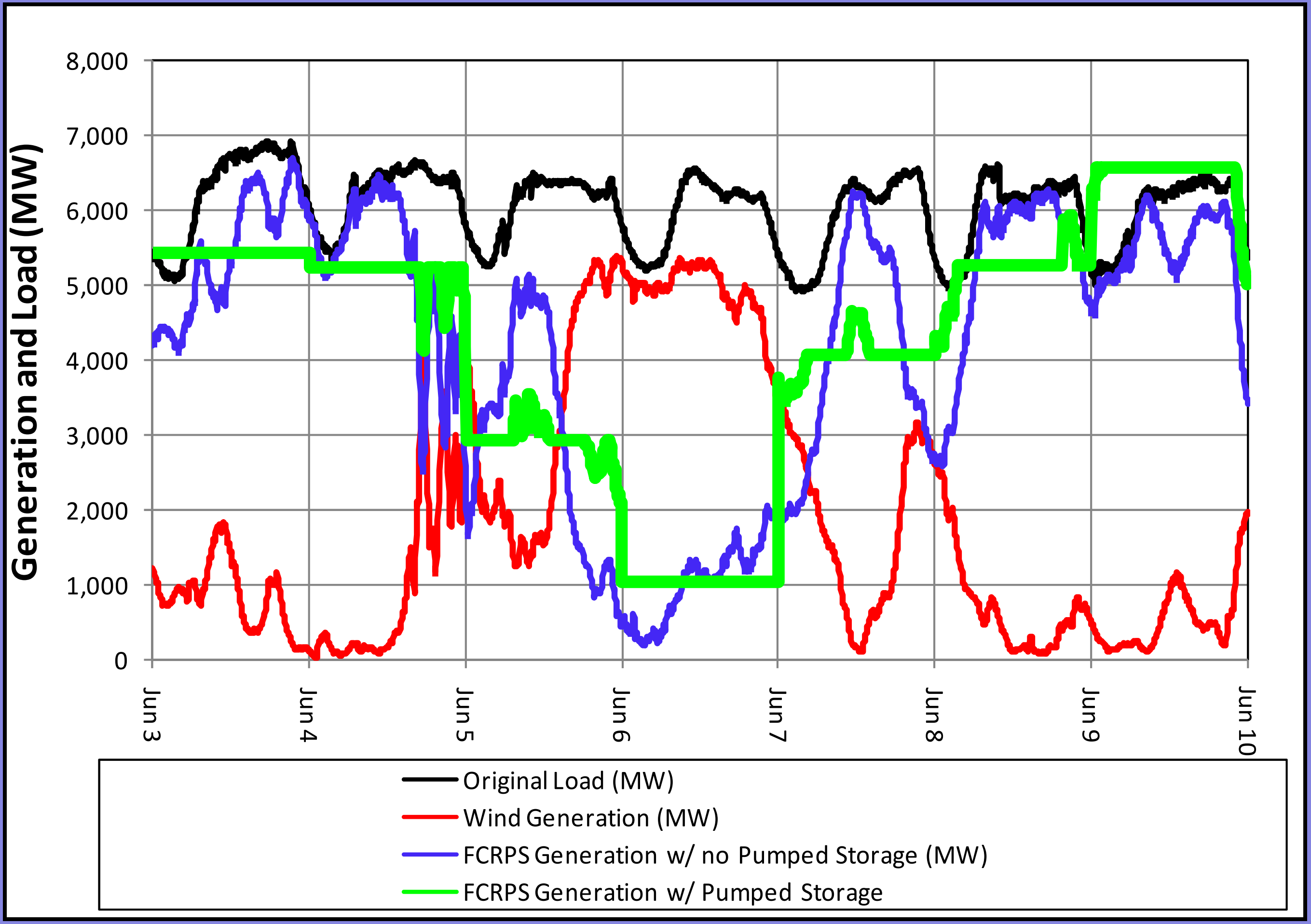
Western Denmark
Wind Output and Net Electricity Flows



Source: *Energinet.dk (Denmark's system operator)*

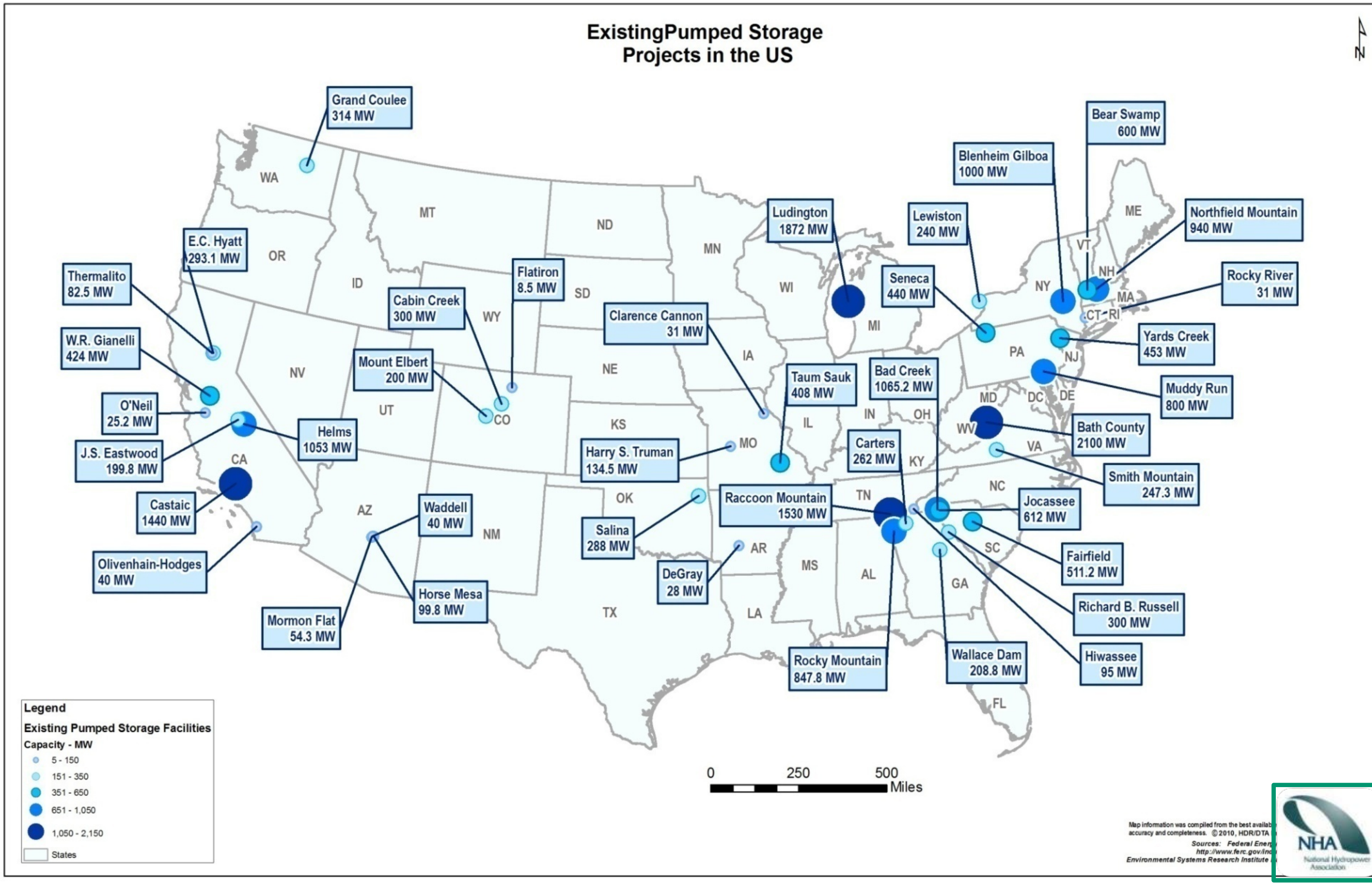
Courtesy: CEPOS, September 2009, Page 12

Historic BPA Load – Managing Reliability & Wind Integration with Pumped Storage

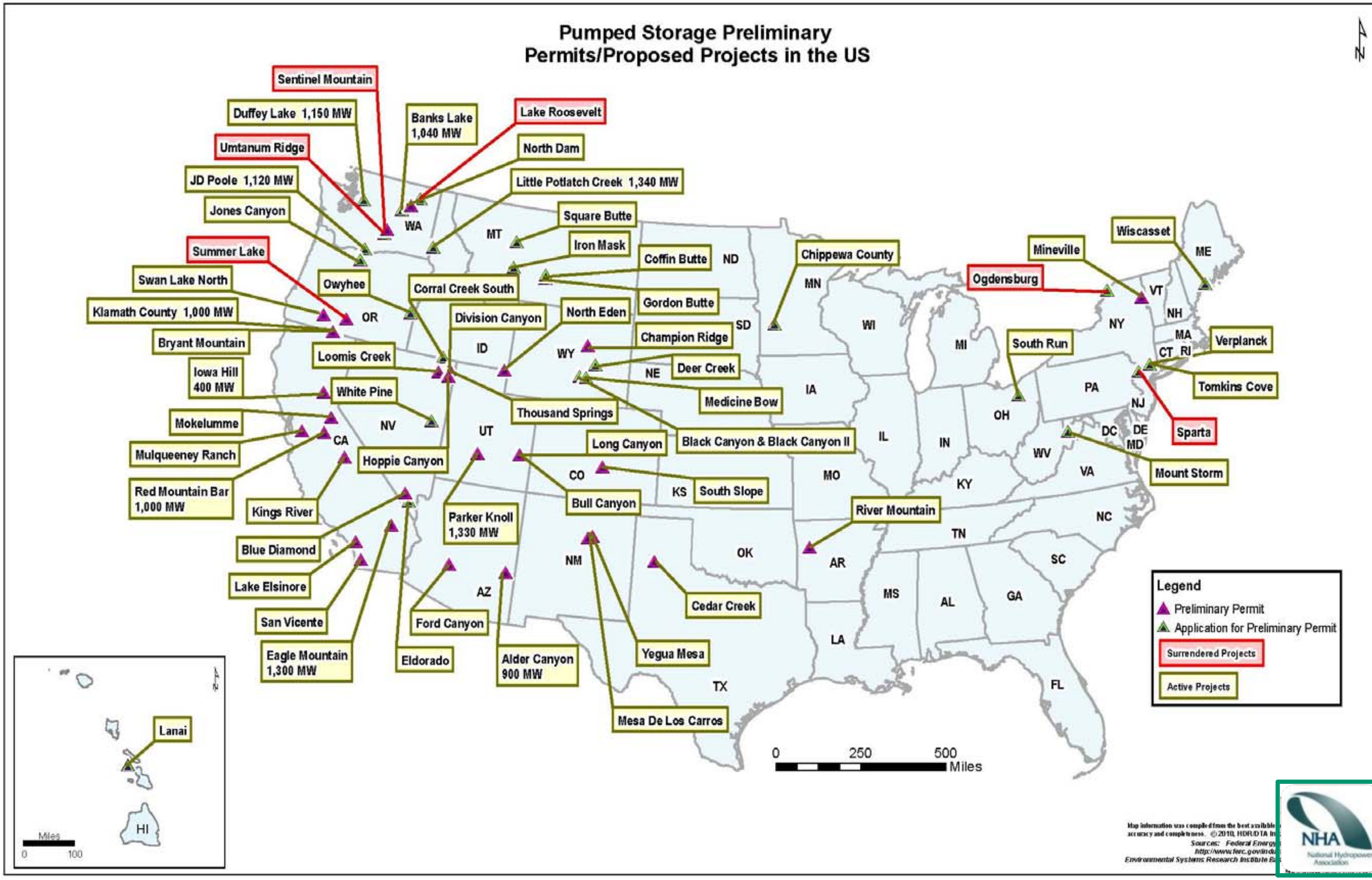


Simulated Approximately 6,250 MW Projected Wind Interconnection and FCRPS Re-Dispatch due to Pumped Storage

Existing Pumped Storage Hydro Plants

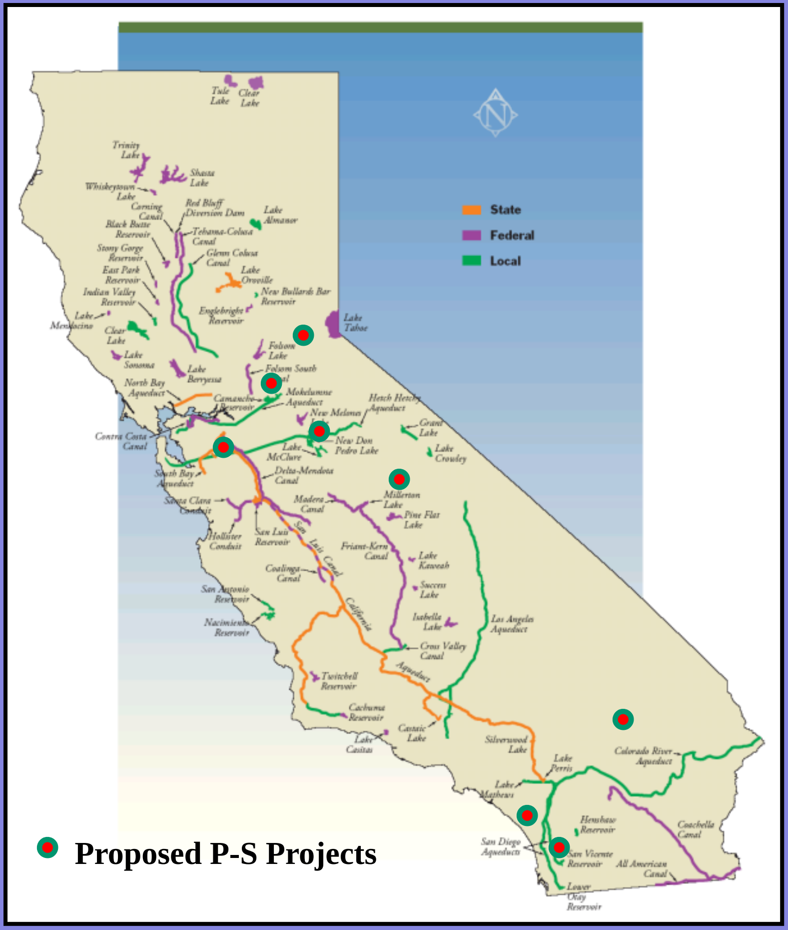


Proposed Pumped Storage Hydro Projects



Pumped Storage in California

- 25% of the Nation's operating pumped storage units
- 8 proposed projects 6,330 MW
  - o Currently in the FERC permitting/licensing process
- P-S meets goals of AB-32:
  - o Peaking capability without air quality impacts (emission free)



NHA
National Hydropower Association

Summary of Pumped Storage Hydro

- Per KEMA and NERC Reports, California needs additional energy storage for renewable integration and grid reliability
- Adjustable speed pump-generating turbines increase flexibility and operating efficiencies
- Pumped Storage currently utilized in Europe to integrate renewable resources, primarily wind
- California has several pumped storage projects in the development phase that could help meet CA's utility-scale storage capacity needs.

<u>Sources of Additional information</u>

http://www.energy.ca.gov/2010publications/CEC-500-2010-010/CEC-500-2010-010.PDF
http://www.nerc.com/files/2010%20LTRA.pdf
http://www.nerc.com/docs/pc/ivgtf/IVGTF_Task_1_5_Final.pdf
http://www.nerc.com/docs/pc/ivgtf/IVGTF_Task_1_4_Final.pdf

NHA National Hydropower Association

Thank You

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California Energy Commission
Staff Workshop
November 16, 2010

Cost-effective, Smart Grid-enabled, Utility-scale Distributed Energy Storage

Frank Ramirez
CEO
framirez@ice-energy.com

ICE ENERGY®
CLEAN ENERGY DOESN'T GET ANY COOLER THAN THIS.

ICE ENERGY

Intelligent Distributed Energy Storage.

Overview

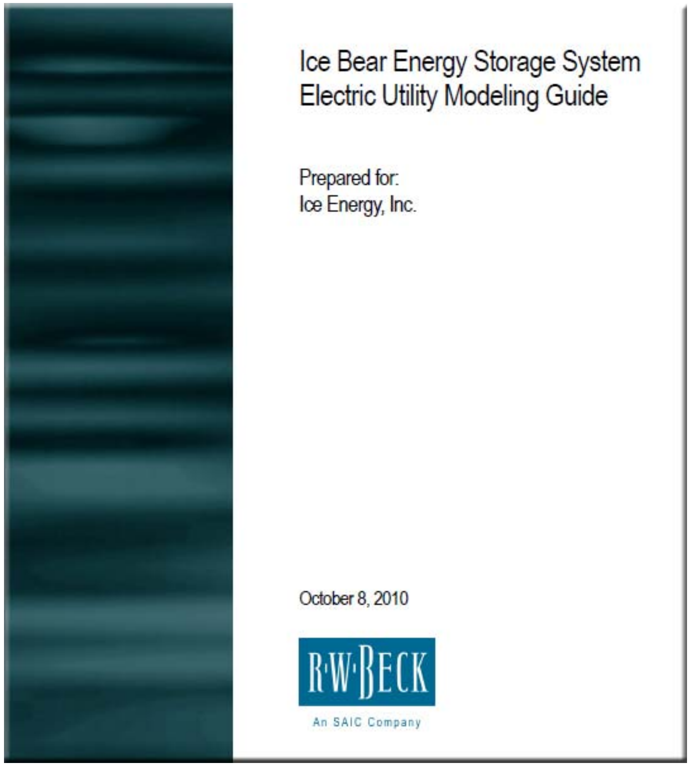
- Intelligent Distributed Energy Storage is:
  - Proven
  - Reliable
  - Cost effective
  - Smart Grid enabled
  - Available for large scale deployment
- Intelligent Distributed Energy Storage Benefits:
  - Reduction of summer peak demand
  - Better integration of renewables,
  - Deferral or avoidance of peaking plants, T&D
  - Reduction of carbon and NOx
  - Creation of hundreds of local California jobs

Proven Technology – Commercially Available

- More than 5 million hours of field collected data
- Successful pilots by 24 utilities over a seven-year period
- Advanced manufacturing plant in Hammondsport, New York
- Existing 53 Megawatt Utility Scale Contract with SCPPA
- Industry OEM Partnerships:
  - OSIsoft PI enterprise infrastructure
  - AT&T wireless 3G network services
  - Trane "Ice Ready" high efficiency rooftop units
  - Carrier "Ice Ready" high efficiency rooftop units

Benefits of Distributed Energy Storage

- Improved system efficiency
- Avoided or delayed simple cycle peakers
- Avoided or delayed T&D system expenses
- Reduction in reactive power requirements
- Increased system power transfer capability
- Improved daily electric system load profile
- Avoided electric system losses
- Enhanced integration of renewable resources
- Improved system power factor & voltage support
- Eliminates fault-induced delayed voltage recovery (AC stalling)


Ice Bear Energy Storage System
Electric Utility Modeling Guide

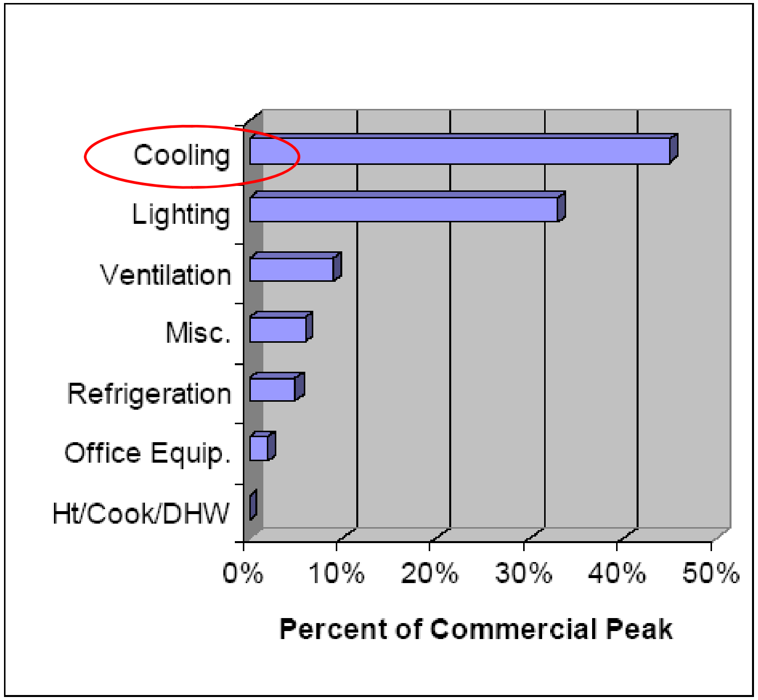
Prepared for:
Ice Energy, Inc.

October 8, 2010

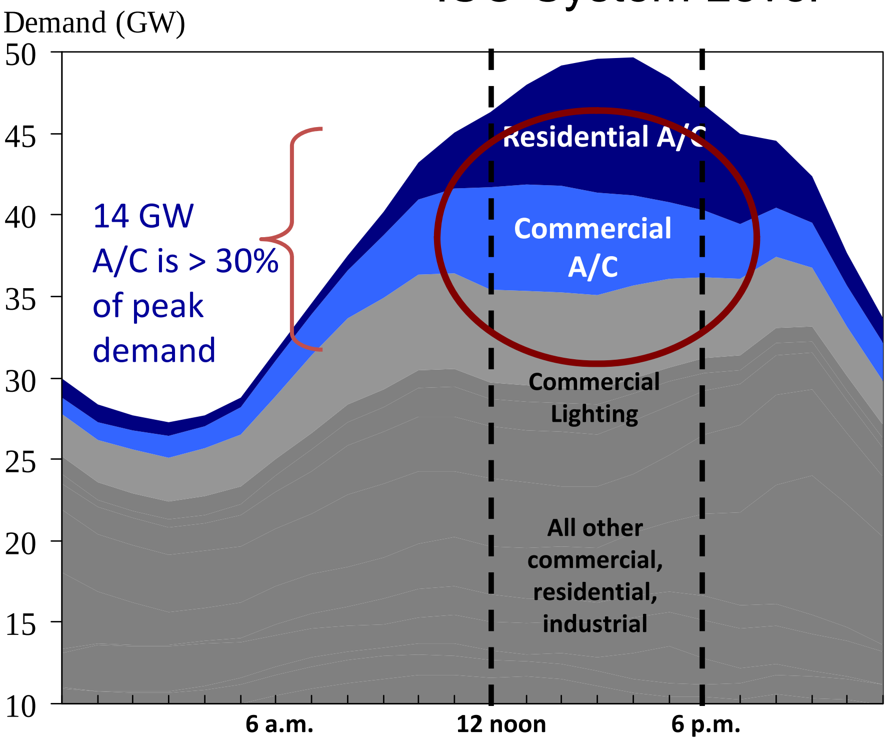
R·W·BECK
An SAIC Company

California Peak Demand Problem: AC Load

Commercial Building Demand

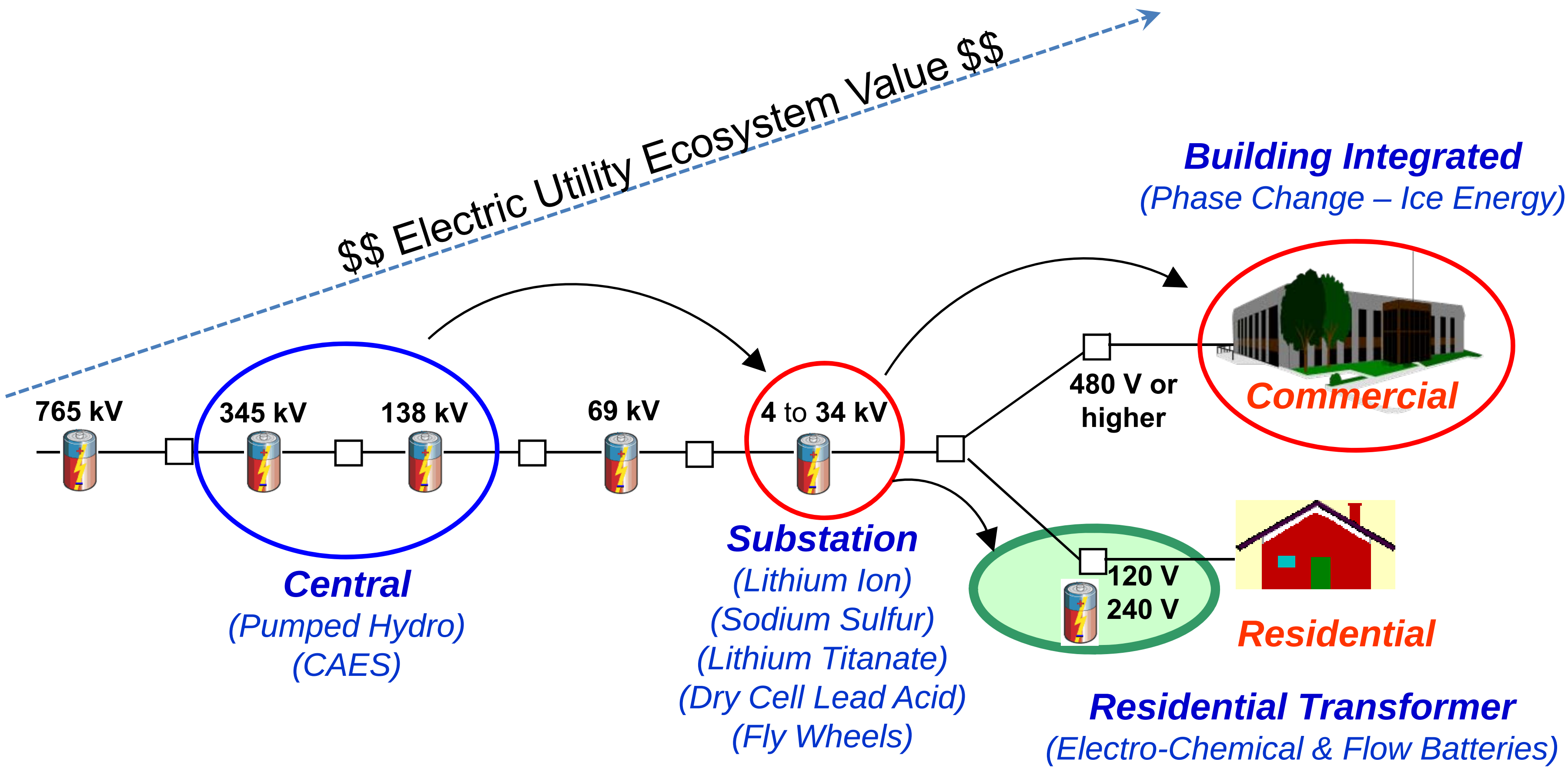


ISO System Level



- Calif. addressable market exceeds 5,000 MW
- Cooling is becoming about ½ the commercial load
- Commercial A/C load extends beyond the utility peak period

Value of Energy Storage Increases as it Approaches the Edge of the Grid



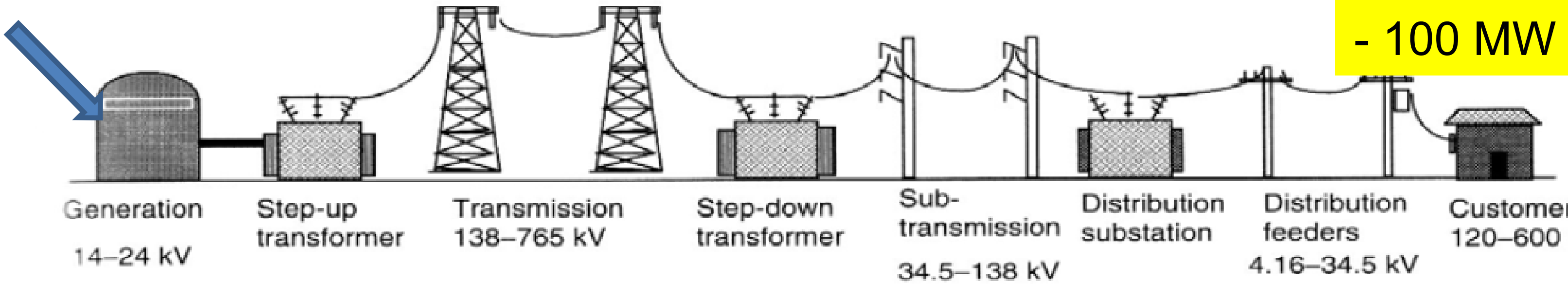
Energy Loss is Greatest During Hottest Periods

Summer Peak Scenario

148 MW Generator Nameplate Capacity & Spinning Reserves

+ 15% Spinning Reserve Margins

- 100 MW Load

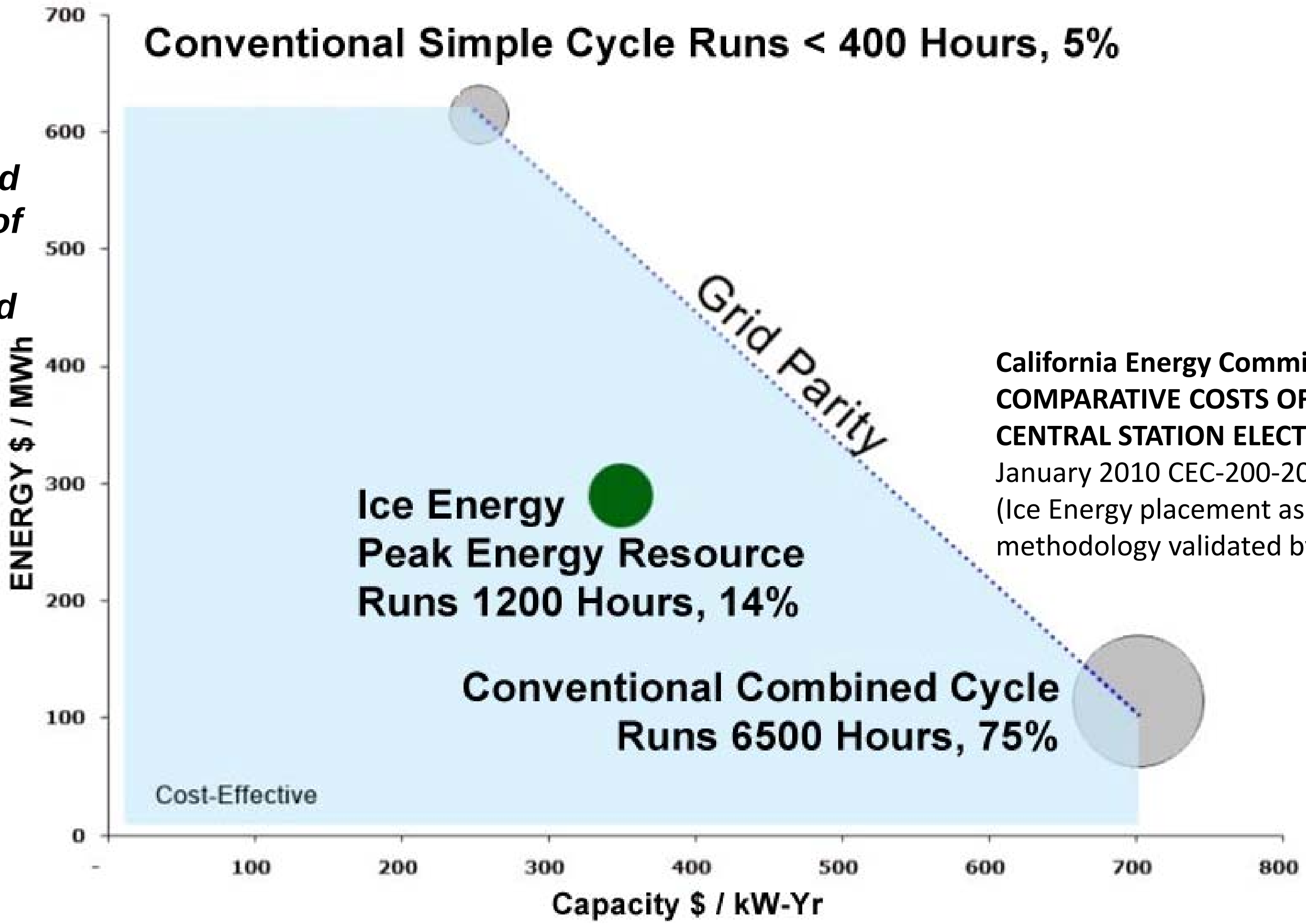


Source-Equivalent Multipliers, by City

City	Grid loss adjustment	Offset peak generation adjustment	Reserve margin adjustment	Source-Equivalent Multiplier
Albuquerque, NM	112.0%	145.2%	115.0%	187%
Atlanta, GA	111.2%	121.8%	115.0%	156%
Chicago, IL	111.2%	118.7%	115.0%	152%
Denver, CO	111.8%	142.9%	117.0%	187%
Fresno, CA	111.3%	123.5%	115.3%	158%
Houston, TX	111.7%	118.7%	114.0%	151%
Los Angeles, CA	111.5%	114.3%	116.0%	148%
Miami, FL	111.4%	114.8%	120.0%	153%
New York, NY	112.1%	116.6%	116.5%	152%
Phoenix, AZ	113.5%	131.7%	115.0%	172%
St. Louis, MO	111.9%	120.2%	114.0%	153%
Washington, DC	112.5%	118.3%	115.5%	154%

Cost Effective Today Without Subsidy

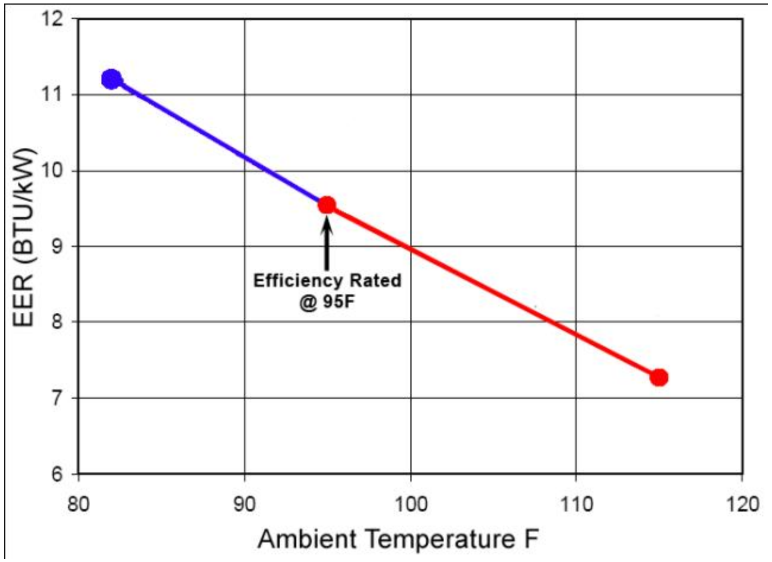
Total lifetime cost measured per unit of energy produced



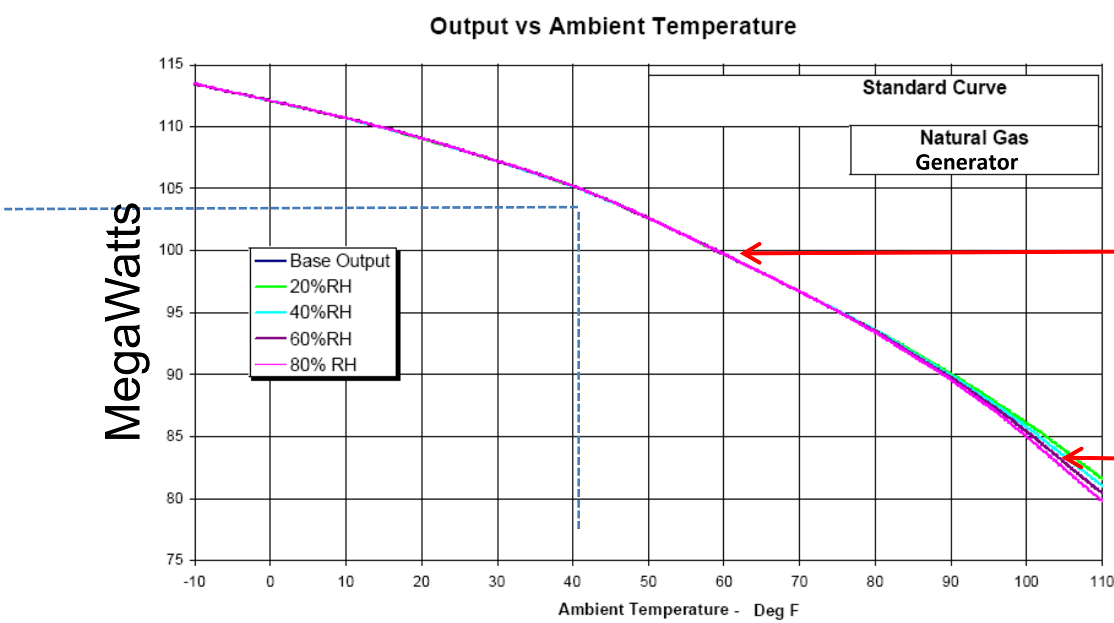
California Energy Commission
COMPARATIVE COSTS OF CALIFORNIA CENTRAL STATION ELECTRICITY GENERATION
January 2010 CEC-200-2009-07SF
(Ice Energy placement as derived from methodology validated by E3)

Total lifetime cost measured per unit of power production capacity

Energy Efficiency of Traditional Compressors and Peaker Plants Decrease with Heat



HVAC Compressor energy efficiency decreases as temperatures rise; thus energy demand increases to maintain cooling and comfort.



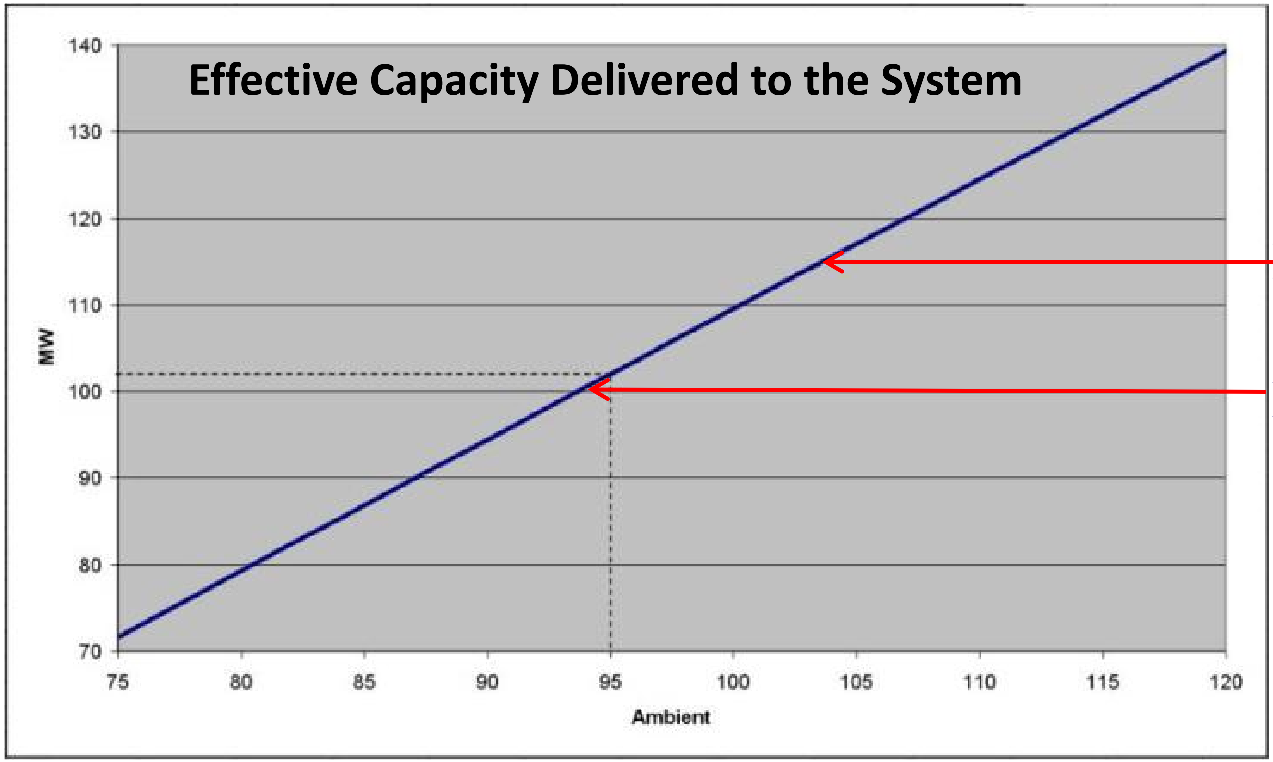
For generating plants, power output and efficiency decrease as temperatures rise:

- **100 MW @ 60°F (name plate capacity)**
- **83 MW @ 105°F**

System Capacity Effect of Ice Bear Deployments

➢ The efficiency of the electrical system - generation, transmission, distribution and mechanical systems - degrades as temperatures rise.

➢ Therefore, the value of thermal storage to the electrical system increases in direct proportion to the rise in temperature

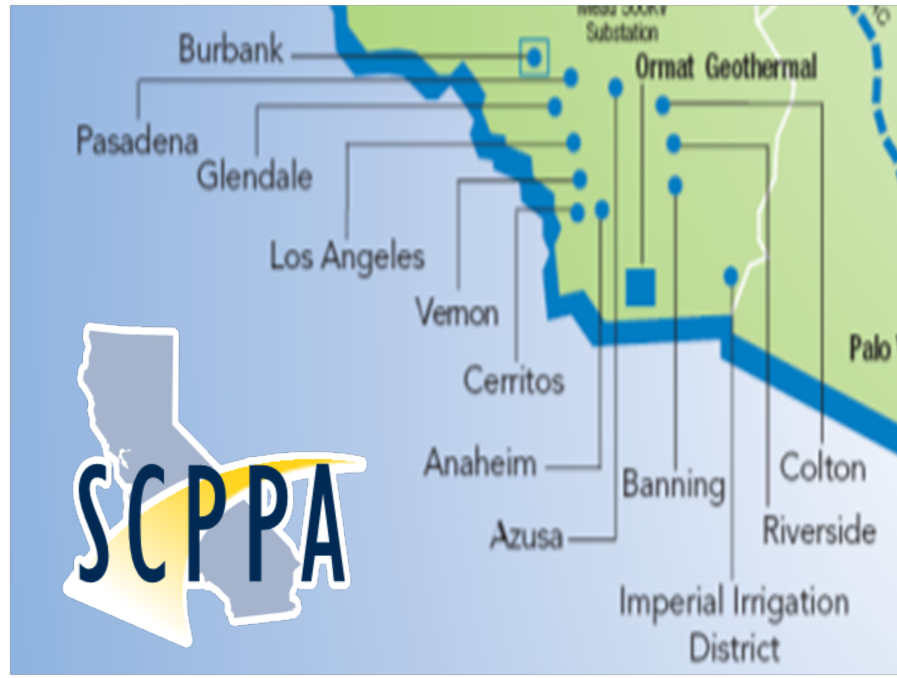


➢ **115 MW @ 105°F**

➢ **100 MW @ 95°F**

Southern California Public Power Authority

- Joint powers authority with 11 municipal utilities and 1 irrigation district in So Cal
- $4.4 billion in annual revenues
- 8,800 megawatt peak demand
- Delivers electricity to ~2 million customers over 7,000 square miles



Applicable to Nearly All Building Types

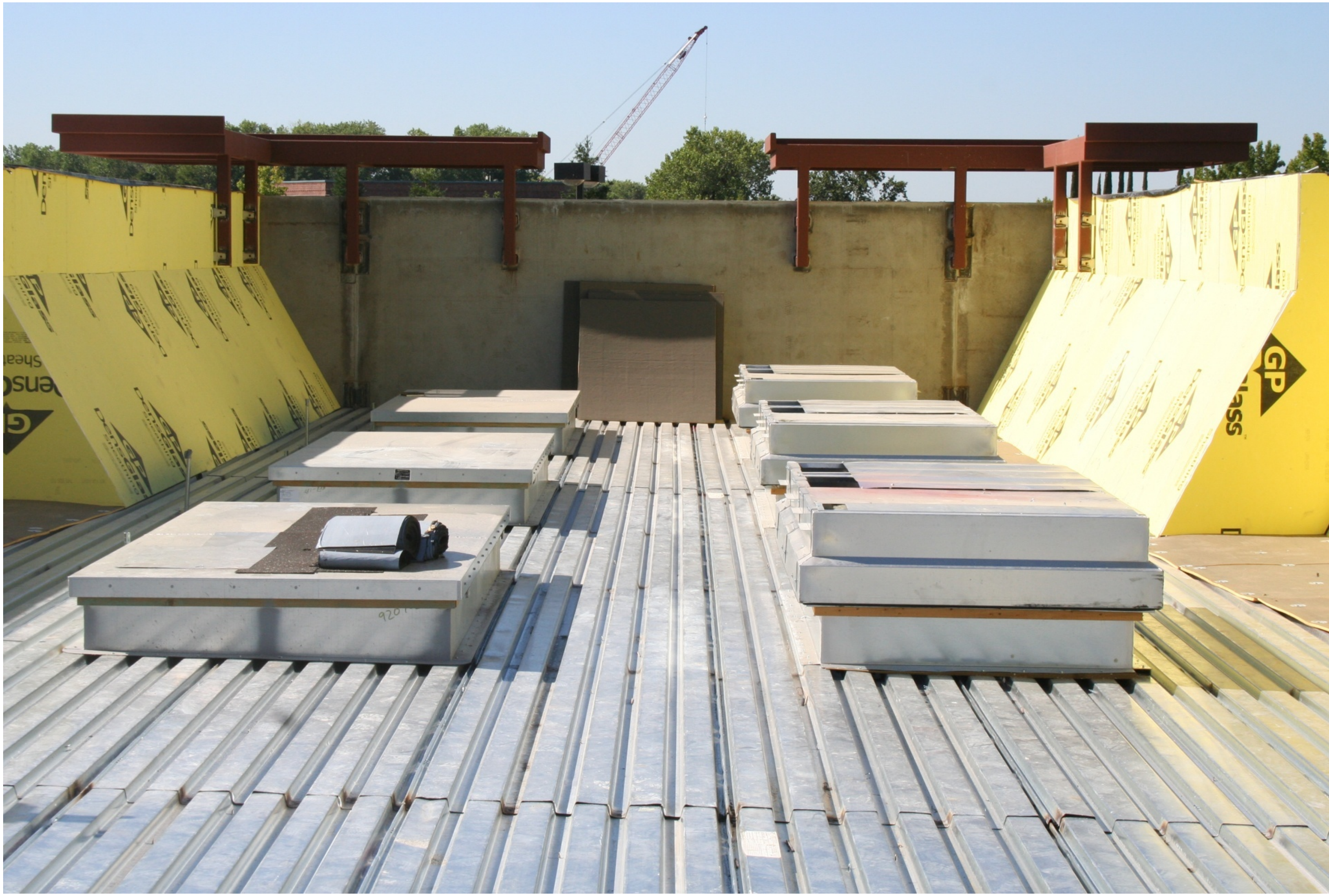
Customer Acquisition & Commissioning
Mature, High Quality, & Turnkey

Box Retailer


HAWAIIAN
BIG COUNTRY
BANANA CHOCOLATE CHIP
CRISP BURRITOS
Put more GO in your TO-GO
Try Our NEW FLAVORS
FLORIST
LAMINATE
RUGS

Fast Food

Ice Ready Rooftop Units Directly from Trane & Carrier Factory



11 Units Federal Building
New Construction w/Solar PV

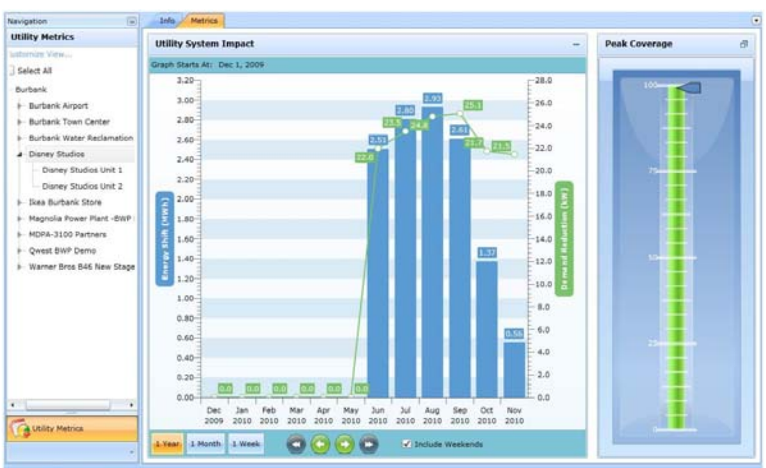
Ice Energy is More Than Just the Ice Bear

= cost-effective, scalable storage & performance

Distributed resources

Real-time control

Aggregated units managed as a single resource.



CoolData Smart Grid Architecture:

- Reliable
- Scalable
    - Supports 30,000 On-line Users
    - Supports 100 GigaWatts of distributed resource

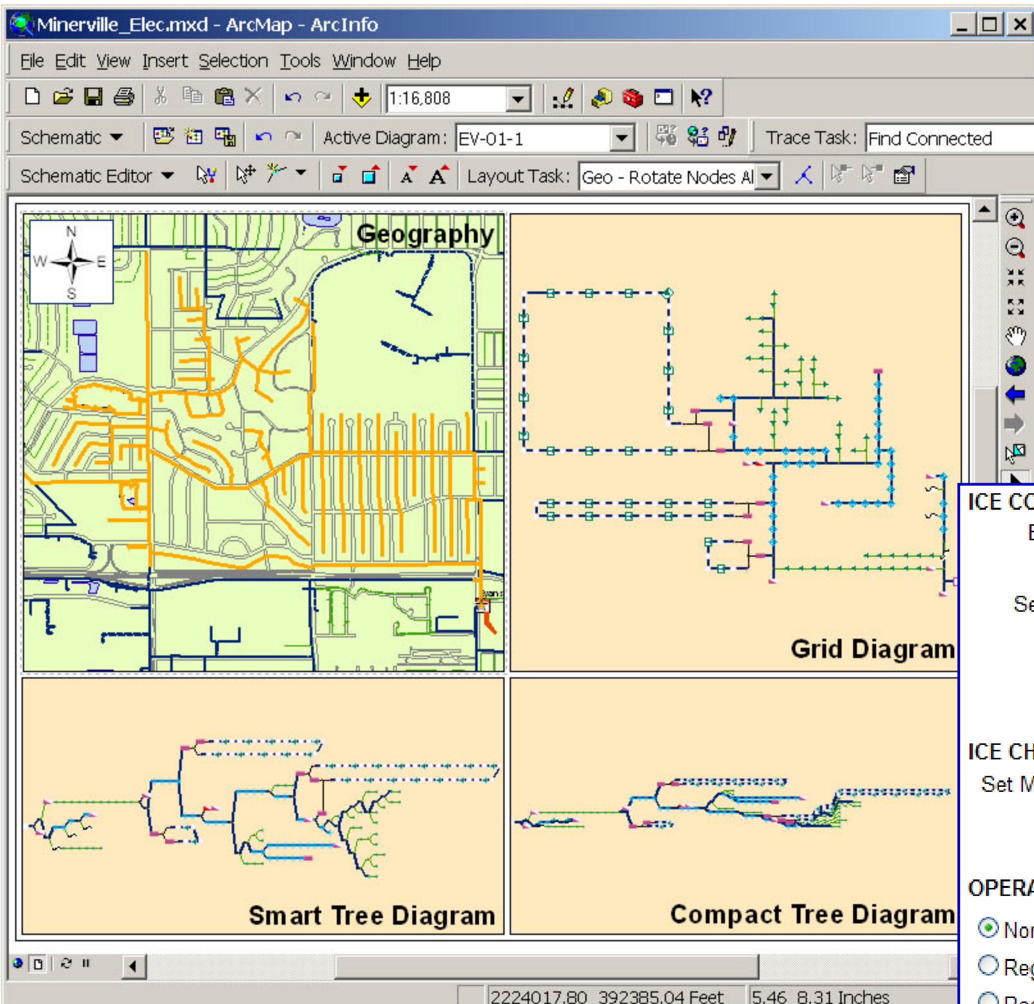
Utility-Configurable Dashboard

➢Provides control, measurement, verification, and custom-defined reporting

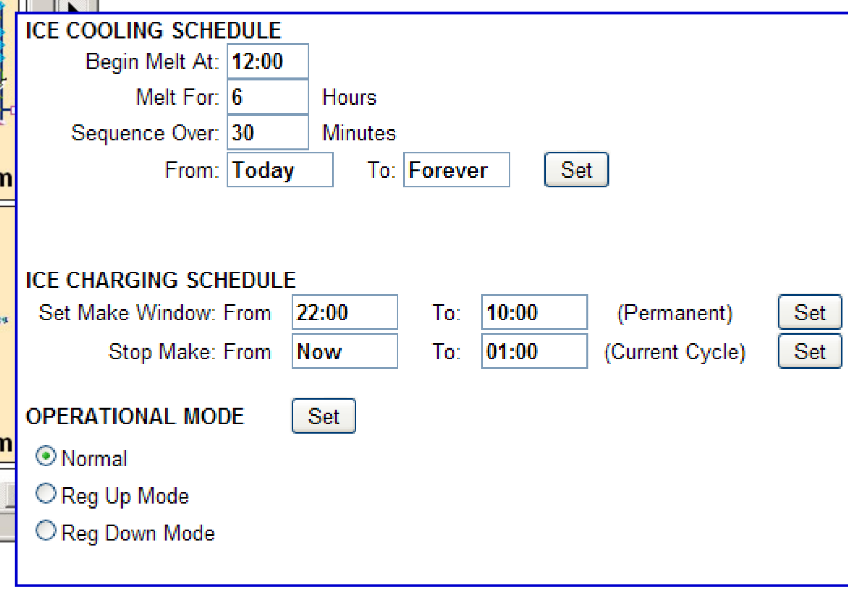
➢Organize and summarize results as needed with flexible navigation pane.

➢ Organized by Area, Substation, Feeder, and Building.

Resource Ties Directly into Utility Operations Providing Dispatch & Control



Schedule changes can be made on-the-fly in response to changing system conditions. Apply different control strategies to one, all or any subset of storage devices



Recent Highlights

- CSI Grant SUN + ICE, SunPower, Target, Ice Energy, **KEMA**, Sandia Labs
- Redding Electric Utility – Social Security Building, New Construction 12 Trane units
- Glendale – Upgraded and replaced most city owned HVAC units + Ice
- FirstEnergy - **EPRI** Smart Grid Project with Staples in Howell, NJ
- Ontario Power Authority – Large Demo Grant with Toronto-Hydro and Veridian

Paul Hauser Director of REU

Ice Bear and Trane Ice Ready RTU's

Distributed Energy → Distributed Job Creation

High Local Content

A 100 Megawatt project will generate roughly 300 direct jobs paying hourly wages of $60 million associated with the building of units, installation, and commissioning.

Field Crews: Electricians, Crane Operators, Instrument Technicians, HVAC Technicians, Landscapers, Roofers, Truck Drivers

Manufacturing: Supervisors, Materials Handling, Quality Control, Administration, Warehouse Logistics, Factory Manager, Assemblers, Operators, Technicians

Business: Legal/Accounting, Application Support, Permitting, Mechanical Design Engineer, Electrical Design Engineer, Inside Sales Support, Call Center, Outside Sales, Materials Manager, Customer Marketing

Economic Development Impact - Multiplier Effect: 4x – 7x

<u>These jobs can – and should be – in California!</u>

Barriers to Adoption of Cost-effective Intelligent Distributed Energy Storage

- Inadequate familiarity with storage's recent technological progress and extensive benefits
- Lack of generally agreed upon cost-effectiveness methodology
- Insufficient recognition of system-wide energy/cost inefficiencies during peak
- Regulatory regimes do not yet fully consider storage
- Incomplete internalization of numerous environmental and other externalities
- Challenges of optimally and cheaply integrating renewables only now being fully recognized

Summary

- Proven, Reliable, Cost Effective, Commercially Available, Long Asset Life
- Distributed Energy Storage delivers the greatest value to the utility ecosystem
- Aggregated Distributed Energy Storage is MW and GWh scale
- Utilities and entire grid can satisfy multiple goals with one measure
  - Save ratepayer $$, shift energy consumption to off-peak rates
  - Reduce peak demand
  - Increase existing asset utilization
  - Replace old less efficient HVAC units
  - Integrate energy only renewables, SUN + ICE
  - Defer and avoid building unneeded peaking facilities
  - Improve distribution circuit reliability
  - Reduce carbon and smog
  - Create living wage local jobs
- We request that Distributed Energy Storage be included by the Energy Commission in the IEPR and other relevant policy proceedings as a valuable, utility-scale, cost effective, renewables-integrating, commercially available resource.

Importance of Energy Storage to California's Renewable Future

November 16, 2010

CESA was founded in January 2009

Our Mission *Expand the role of storage technology to promote the growth of renewable energy and create a cleaner, more affordable and reliable electric power system*

Steering Committee

- AIC Applied Intellectual Capital – Ventures in Sustainable Technology
- East Penn International
- Altair Nano
- Beacon Power
- Chevron Human Energy
- Fluidic Energy
- Ice Energy
- MEMC – Technology is built on us
- Silent Power Inc.
- Xtreme Power

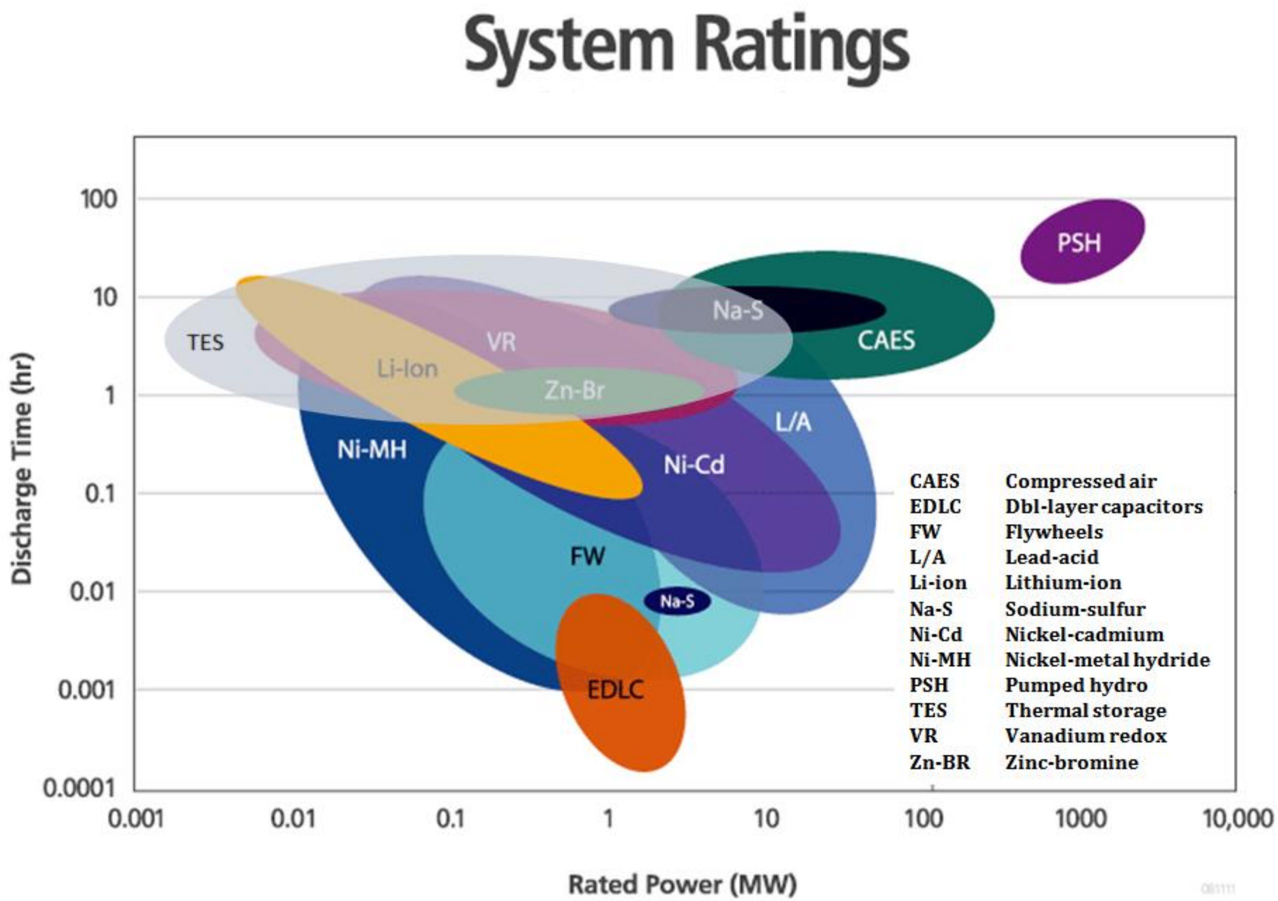
General Members

- A123 Systems
- Debenham Energy, LLC
- Deeya Energy
- EnerSys
- EnerVault – Launching a Clean & Secure Energy Future
- General Compression – expanding clean power
- International Battery – World Class. American Made.
- Powergetics
- Primus Power – Smart Grid Storage
- Prudent Energy
- PVT Solar
- Redflow
- Restore Energy Systems – A Division of Exide Technologies
- Saft
- Samsung SDI
- SEEO
- Suntech
- Sunverge – Renewable Made Reliable
- SustainX – Energy Storage Solutions

CESA – California Energy Storage Alliance

What is Energy Storage?

Energy storage 'stores energy' for use at a later time.
Many types of mechanical, thermal and chemical storage technologies are commercially available today.



Examples of Advanced Energy Storage Projects:

12 kW Thermal Storage – Napa Community College (Ice Energy)

34 MW NAS battery @ 51 MW wind farm – Japan (NGK)

3 MW Mechanical Storage for A/S – NE ISO (Beacon Power)

1MW Lithium Titanate Battery for A/S –PJM (Altairnano)

Examples of Advanced Energy Storage Projects:

5 MW Thermal Storage – LA Community College (Calmac)

115 MW Compressed Air Energy Storage

1 MWh Battery in Maui, Hi (Xtreme Power)

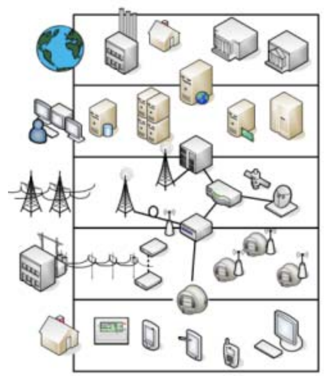
2 MW Li-Ion Battery for A/S – AES (A123)

Key Drivers of Growth for Grid Storage

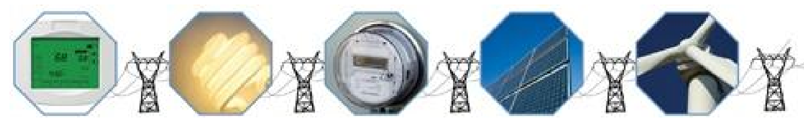
Smart Grid

"Our expectation is that this [smart grid] network will be 100 or 1,000 times larger than the Internet"

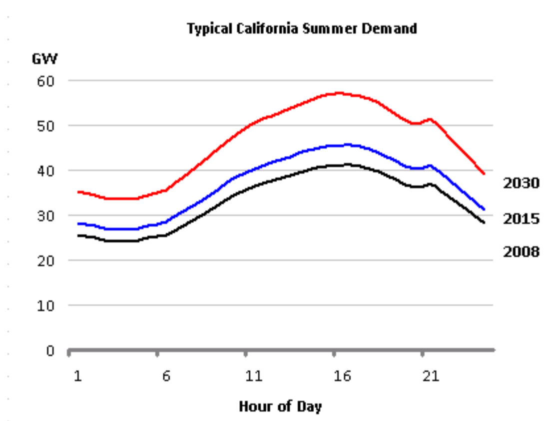
- Cisco, May 2009



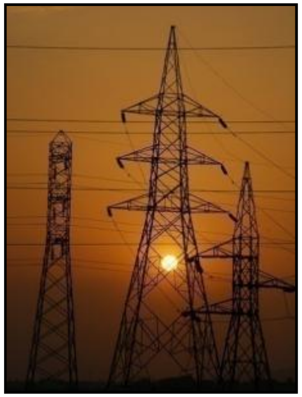
Renewables Integration



Peak Load Growth



Transmission Constraints

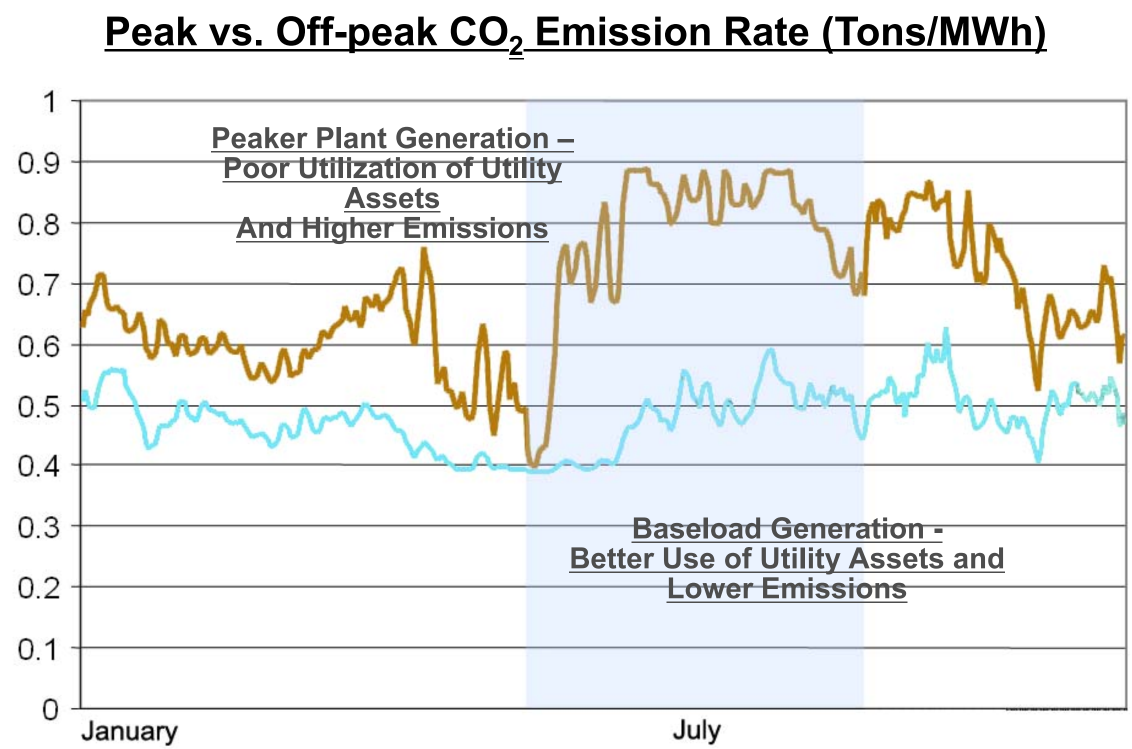


CALIFORNIA ENERGY STORAGE ALLIANCE

Another Key Driver: Storage Reduces GHG Emissions

» **Percent CO_2 / MWh Reduction Shifting from Peak to Off-Peak:**
  - **SCE: 33% reduction**
  - **PG&E: 26% reduction**
  - **SDG&E: 32% reduction**

» **Also ~56% lower NO_x emissions**



E3 Calculator	Tons CO_2 / MWh		
	Summer On-Peak	Summer Mid-Peak	Summer Off-Peak
Utility			
PG&E	0.67	0.61	0.49
SCE	0.72	0.63	0.49
SDG&E	0.69	0.58	0.47

1) Source: Southern California Edison

Storage Provides Four Timely Benefits to California

1. Energy storage deployed in CA will create jobs for CA
   - Direct installation of projects in California
   - New manufacturing capacity
   - Spur enabling communications and controls technologies
2. Energy storage supports CA’s landmark legislation (AB 32) to reduce GHG emissions and conventional pollutants
3. Energy storage will help CA achieve a RPS of 33% by 2020
4. Energy Storage is a key component of CA’s smart grid goals

Energy storage and its many applications is the focus of AB 2514

AB 2514 – Landmark New Storage Legislation

AB 2514 requires procurement of new storage capacity

- Would establish **Energy Storage Procurement Targets for 2015 and 2020 (2016 and 2021 for POUs)**
- Sponsored by Jerry Brown, California Attorney General
- Authored by Assembly member Nancy Skinner, Chair, Assembly Rules Committee
- Directs CPUC to convene a proceeding to evaluate energy storage procurement targets:
  - Technology neutral – but must be cost effective
  - Application neutral
  - Utility owned, customer owned, and third party owned are eligible
  - Applies to systems installed after 1/1/10
  - Requires CPUC to consider info from CAISO and integration of storage with other programs, including demand side management
  - Electrical corporations with <60k customers are exempt
- Status – signed into law 9/29/10

AB 2514 provides necessary focus on storage

Energy Storage Enables Multiple Value Streams

Energy storage is a cost effective approach providing numerous benefits to many stakeholders in many applications

Customer	+	Utility	+	System Operator	+	Society
• Reduced energy and demand costs • Emergency back up • Demand response • Improved reliability		• Load leveling • T&D relief / deferral • Improved power quality • Reduce peak gen. and spinning reserve needs		• Ancillary services • Grid integration • Improved grid reliability & security		• More renewables • Fewer emissions • Healthier climate • More jobs

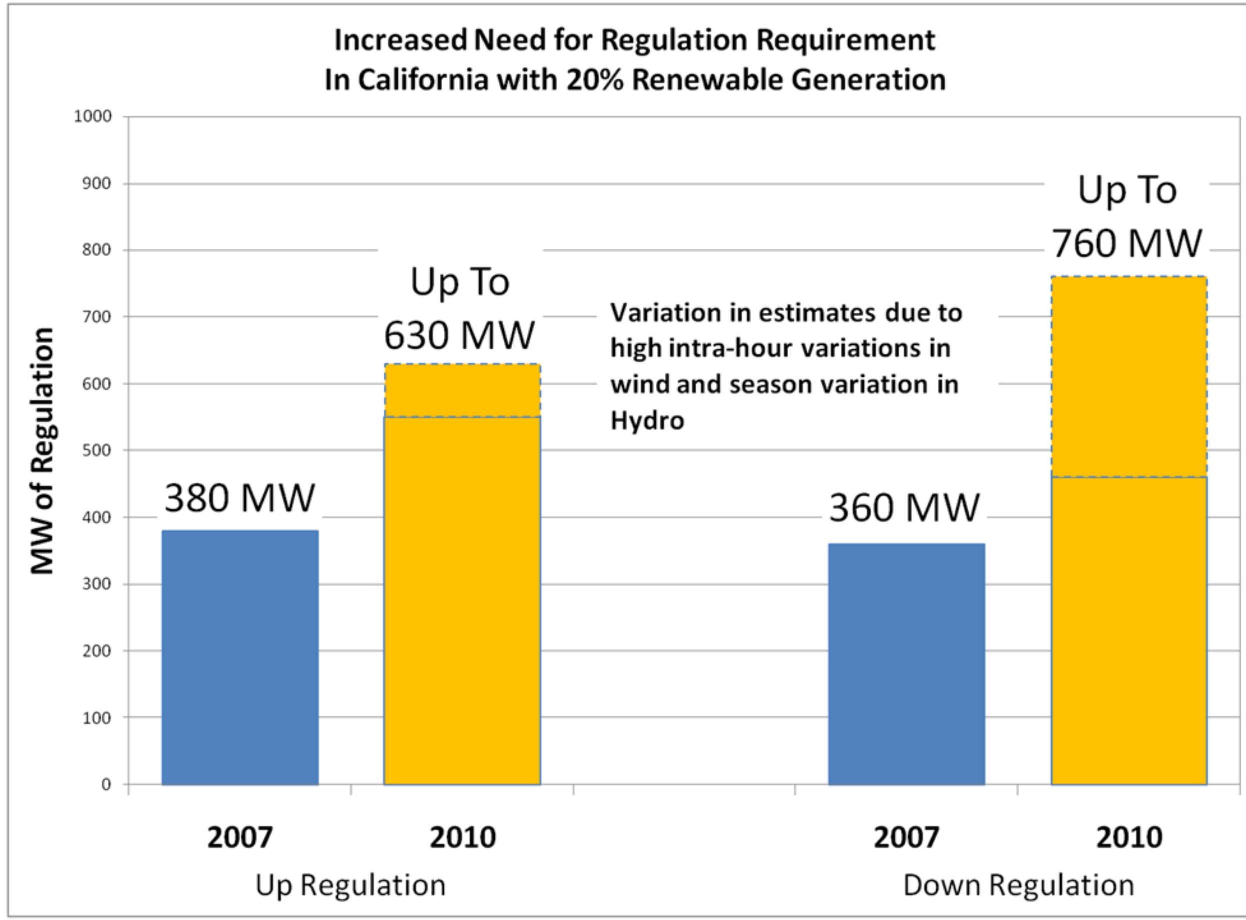
Government intervention is needed to align multiple benefits with the cost!

Storage has several key applications for renewable integration…

1. Cleaner, more effective alternative for frequency regulation
2. Storing renewable over-generation
3. Renewable generation smoothing/shaping
4. Generation shifting (to increase T&D capacity or value of generation)

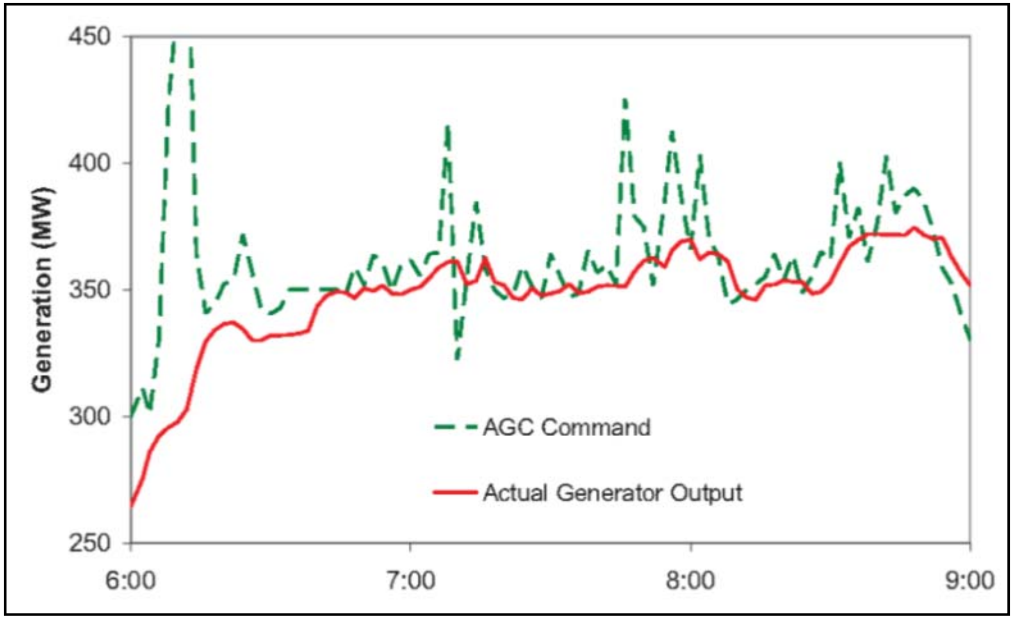
CA's RPS implementation will increase the need for regulation and ramping

- **Increased wind penetration creates need for greater regulation capacity and faster regulation ramping capability**
- **Nov '07 CAISO report identifies significant additional regulation requirements with 20% renewables (about 10% wind penetration)**

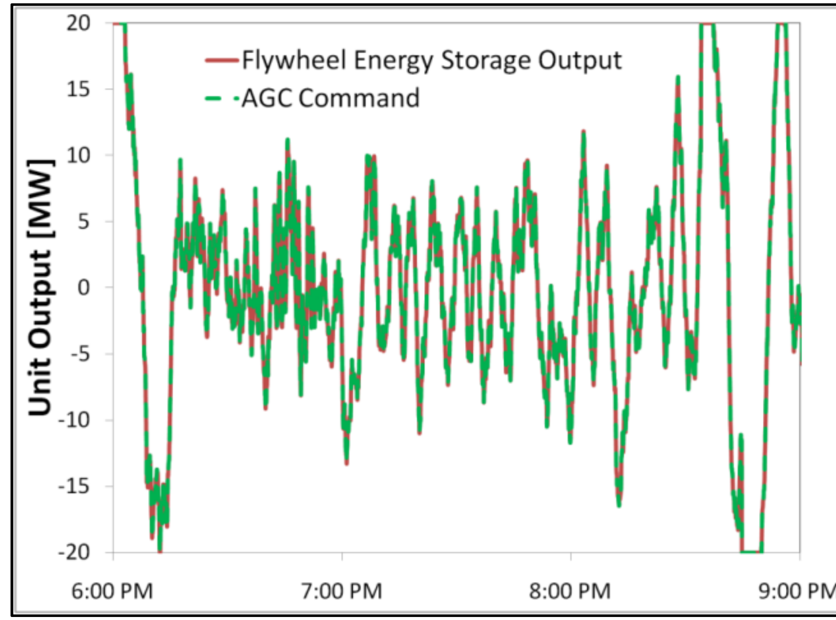


Ancillary services can be provided today at 20 MW scale, and from systems as small as 1 MW on the customer side of the meter

Storage is more capable of following a faster, frequently changing regulation signal



Slow Ramping of Conventional Generator



Flywheel Energy Storage Example

Fast-response energy storage provides near instantaneous response to a control signal

Sources Kirby, B. "Ancillary Services: Technical and Commercial Insights." Wartsilla, July, 2007. pg. 13

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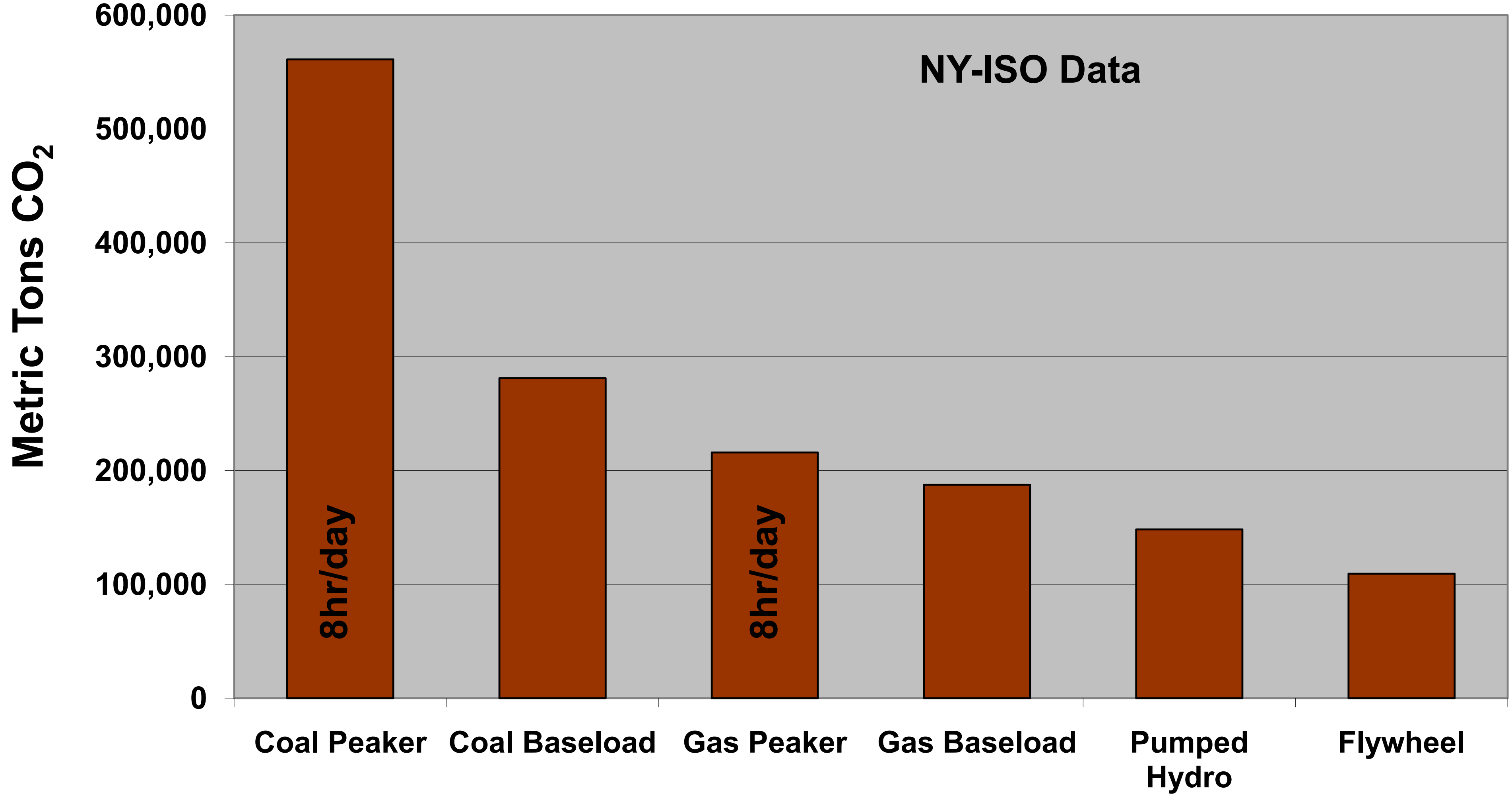
CALIFORNIA ENERGY STORAGE ALLIANCE

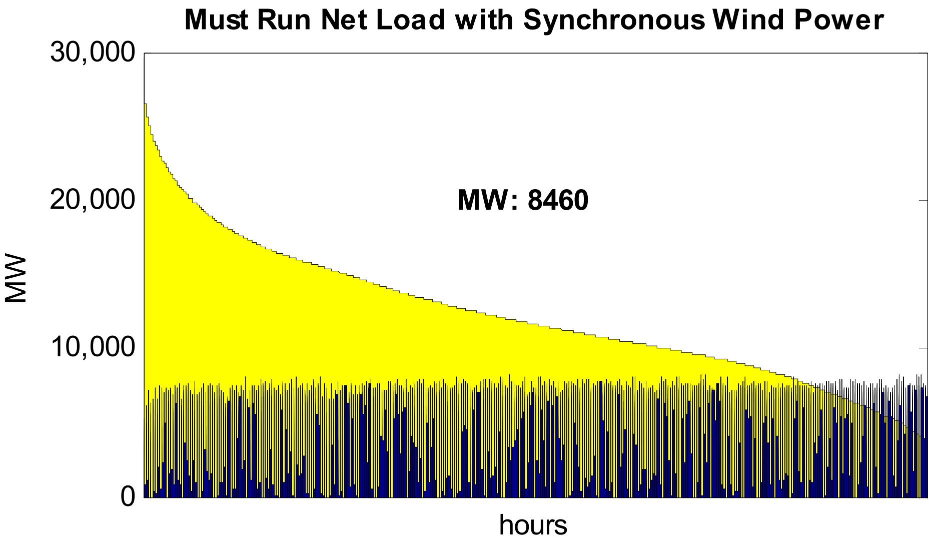
Utilizing storage for regulation dramatically lowers CO2 emissions

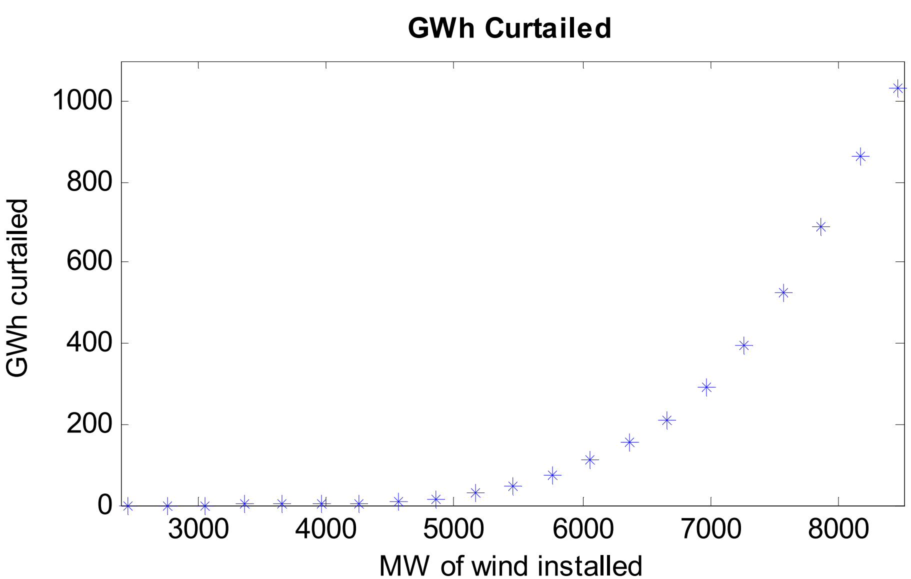
From KEMA Study: 20 MW of Regulation over 20-year operating life



Source: "Emissions Comparison for a 20MW Flywheel Based Frequency Regulation Power Plant" Kema Project BPCC 0003.001
January 14, 2008

Storage can utilize anticipated over generation - 2020





- Estimated wind penetration of ~8,800 MW
  - ~1,700 hours of overgeneration
  - Predominately in Spring Off-Peak hours
- PLS charging during hours with overgeneration receives avoided cost benefit of marginal renewable resource.
  - ~$91/MWh in 2008

Energy+Environmental Economics

Source: E3 PLS Workshop Presentation November 10, 2010

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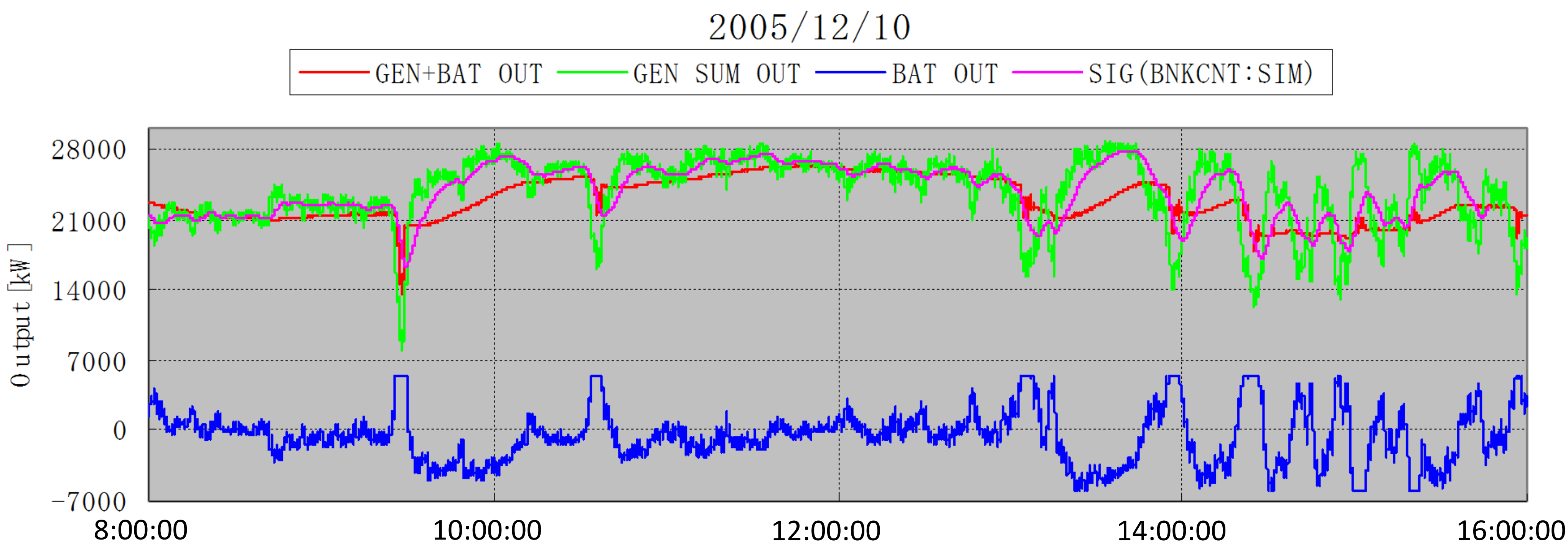
Smoothing - 6 MW VRB-ESS Tomamae Wind Farm, Japan

Daily Wind Output Smoothing at Tomamae

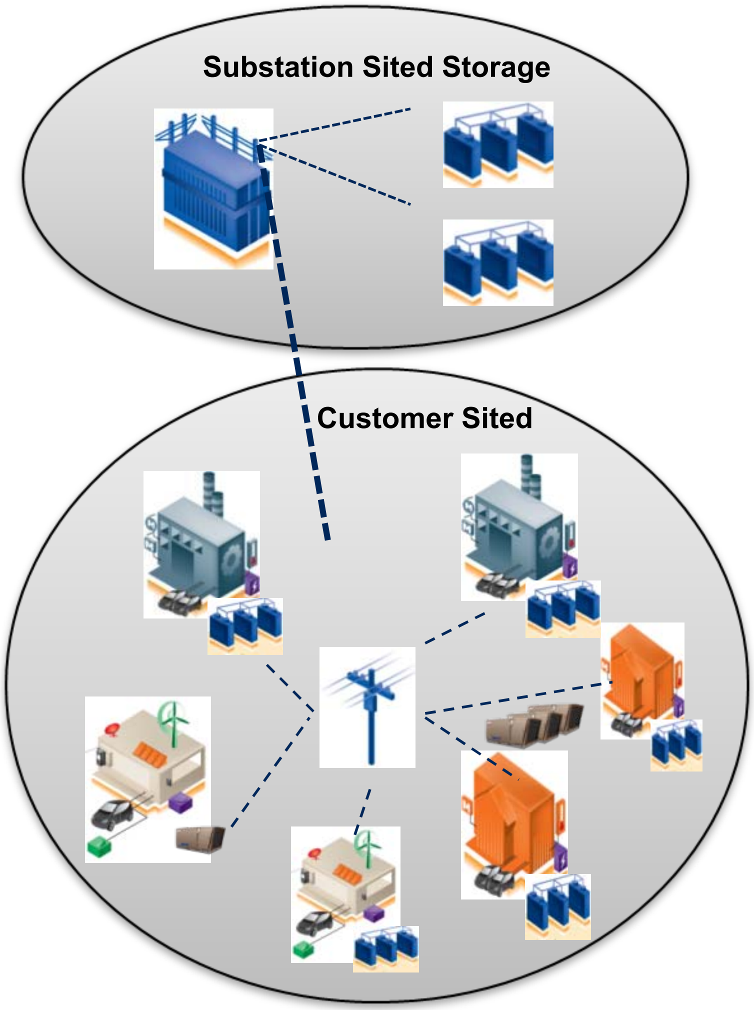


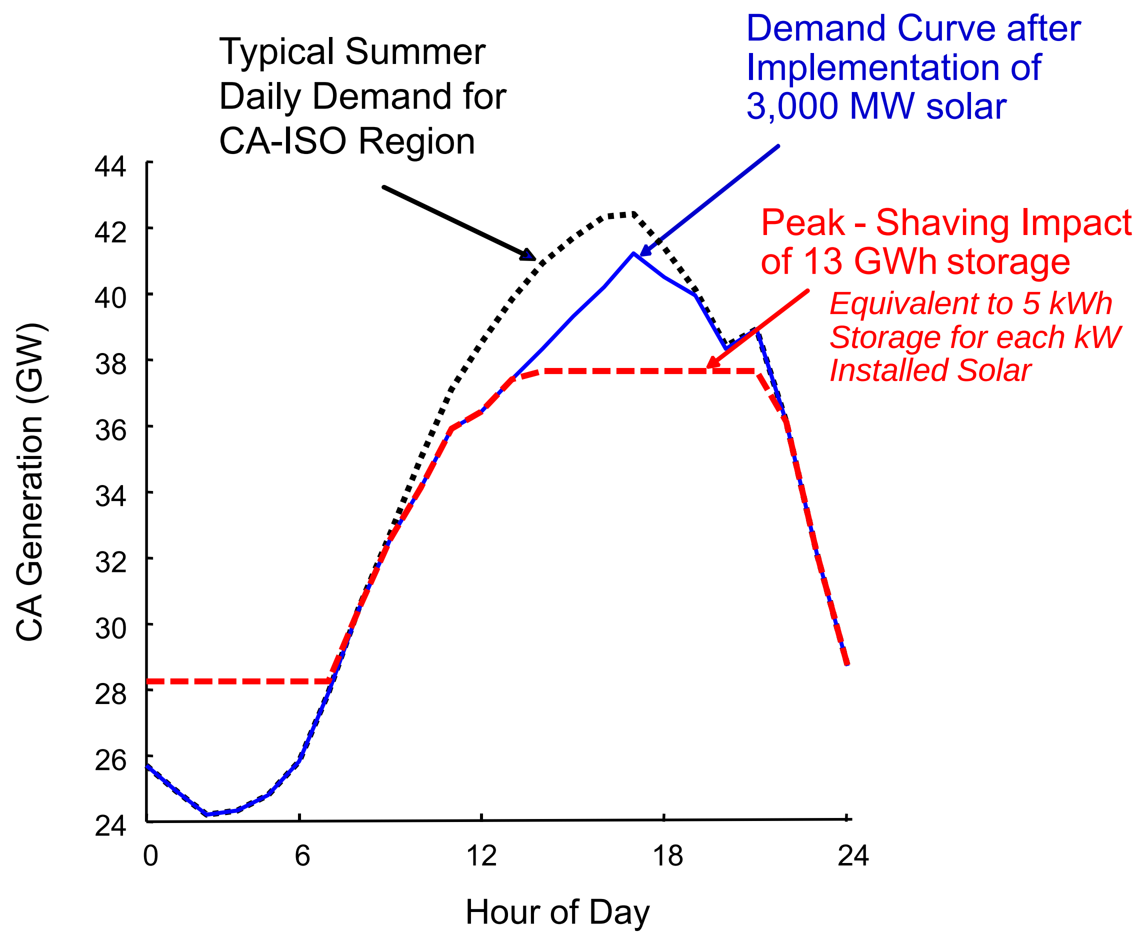
- The VRB-ESS (blue line) runs continuously to smooth wind farm production (green line).
- At only 20% of the windfarm's nameplate capacity, the VRB ESS has a significant smoothing effect to total windfarm + battery output (red line)
- The VRB-ESS intelligently recharges throughout the day so that it maintains 50% SOC

Source: Prudent Energy

Storage can have a significant impact reducing peak

Small distributed systems can have a grid-scale impact





Source: EPRI

CESA CALIFORNIA ENERGY STORAGE ALLIANCE

Energy storage is cost effective! Example: a cheaper and cleaner alternative to natural gas peakers

Gas-Fired Turbine Peaker Plant

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Installed Cost	$1,394/kW	$265	$109
Grand Total		$492	$203

Energy Storage Peaker Substitution

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Installed Cost	$1,351/kW ($338/kWh)	$256	$105
Grand Total		$377	$155

Levelized Cost of Generation for Energy Storage is Less Than a Simple Cycle Gas-Fired Peaker

CESA CALIFORNIA ENERGY STORAGE ALLIANCE

Energy storage is a cheaper and cleaner alternative to natural gas peakers – analysis assumptions

Gas-Fired Peaker Plant[1]

General Assumptions	
Technology:	Simple Cycle Combustion Turbine
Plant Size	**49.9MW**
Efficiency	37% (9,266 Btu/kWh Heat Rate)
Ownership	**POU Owned/Financed**
Project Life	20 years
Capacity Factor	**5%**
Plant, T&D Losses	6% (Centralized Plant)

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Fixed O&M	$24/kW/yr	$69	$29
Corp. Taxes	**0%**	**$0**	**$0**
Insurance	0.6% of CAPEX	$23	$10
Property Tax	**1.1% of CAPEX**	**$29**	**$12**
Natural Gas Fuel	$61/MWh	$100	$41
Variable O&M	**$0.04/kWh**	**$5**	**$2**
Subtotal		$227	$93

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Installed Cost	$1,394/kW	$265	$109
Grand Total		**$492**	**$203**

Energy Storage Peaker Substitution[2]

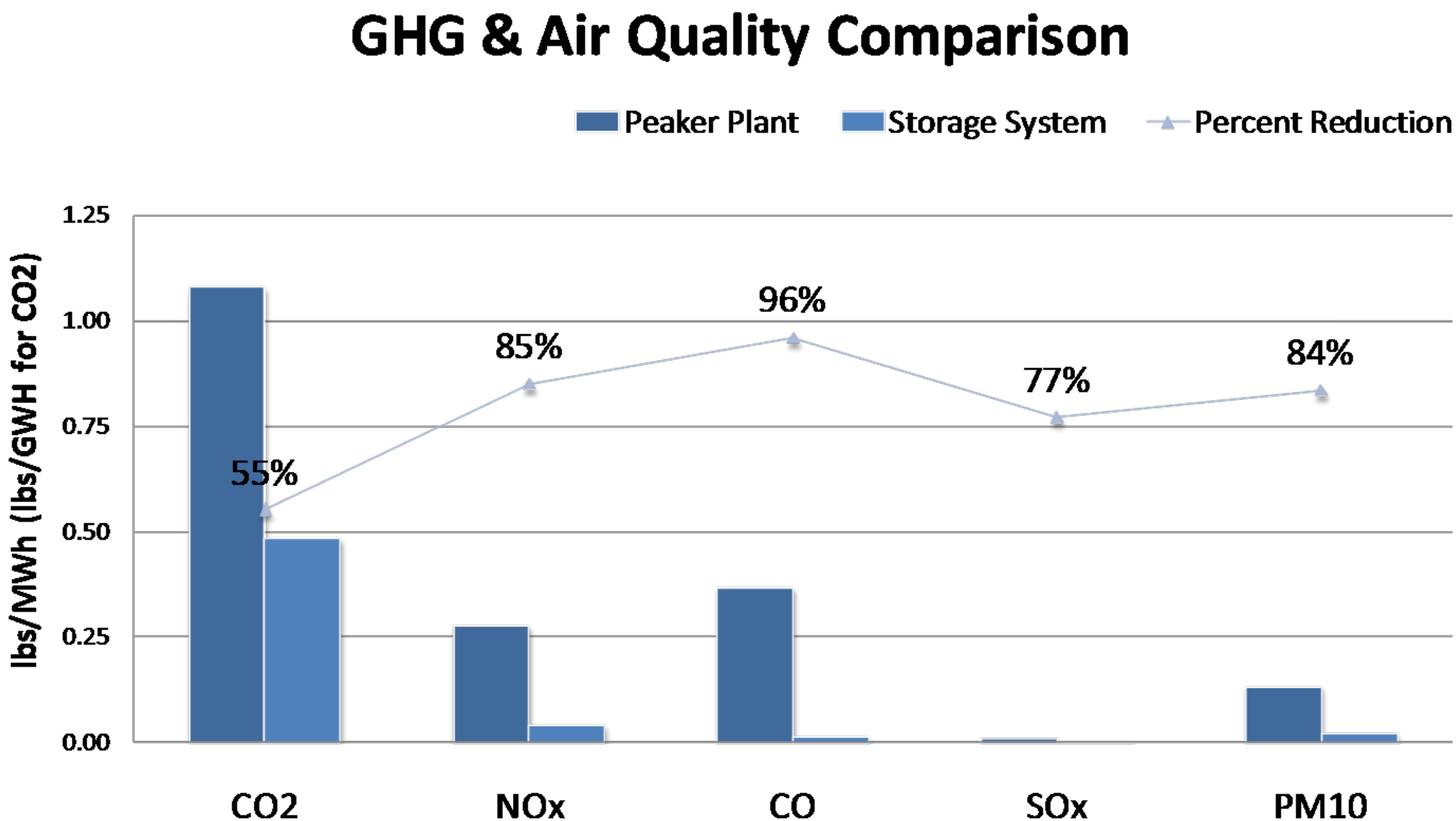
General Assumptions	
Technology:	Lead-Acid Battery
Plant Size	**49.9MW (4h duration)**
Efficiency	84% (AC to AC Roundtrip)
Ownership	**POU Owned/Financed**
Project Life	20 years
Capacity Factor	**5%**
Plant, T&D Losses	6% (Centralized Plant)

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Fixed O&M	$6/kW/yr	$17	$7
Corp. Taxes	**0%**	**$0**	**$0**
Insurance	0.6% of CAPEX	$22	$9
Property Tax	**1.1% of CAPEX**	**$28**	**$12**
Off-Peak Grid Charging	$24/MWh[3]	$48	$20
Variable O&M	**$0.04/kWh**	**$5**	**$2**
Subtotal		$121	$50

Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Installed Cost	$1,351/kW[4] ($338/kWh)	$256	$105
Grand Total		**$377**	**$155**

1) Source: *CEC 2009 Comparative Cost of California Central Station Electricity Generation Technologies* (CEC_COG_Model_Version_2.02-4-5-10)
2) Source: StrateGen Consulting, Levelized Cost of Generation Model
3) Assumes most recent sample of average summer off-peak wholesale price from CAISO OASIS database
4) EPRI Chino Study TR-101787, *Chino Battery Energy Storage Power Plant: Engineer-of-Record Report* (December 1992)

Energy storage is a cleaner alternative to natural gas peakers



1) Assumptions from CEC Cost of Generation Model for simple cycle peaker and standard combined cycle for off-peak base load; generation mix based on annual report of actual electricity purchases for Pacific Gas and Electric in 2008

Energy storage is fundamental to many key California policy initiatives

» 'Foundational' Legislation
  - Energy Storage Procurement Targets: (AB 2514)
  - 33% Renewable Portfolio Standard (Executive Order)
  - Self-Generation Incentive Program: SGIP (SB 412)
  - Smart Grid Systems (SB 17)
  - Global Warming Solutions Act of 2006 (AB 32)
  - Solar Energy System Incentives: CSI (SB 1)

» CEC Integrated Energy Policy Report Planning

» Active regulatory implementation of legislation at California Public Utility Commission
  - Long Term Procurement Planning, Renewable Integration
  - Smart Grid Deployment
  - Self Generation Incentive Program
  - Demand Response/Permanent Load Shifting

» Non-Generator Participation in Ancillary Services Stakeholder Process—California Independent System Operator (CAISO)

Leadership is needed to leverage storage's many strengths across policy initiatives

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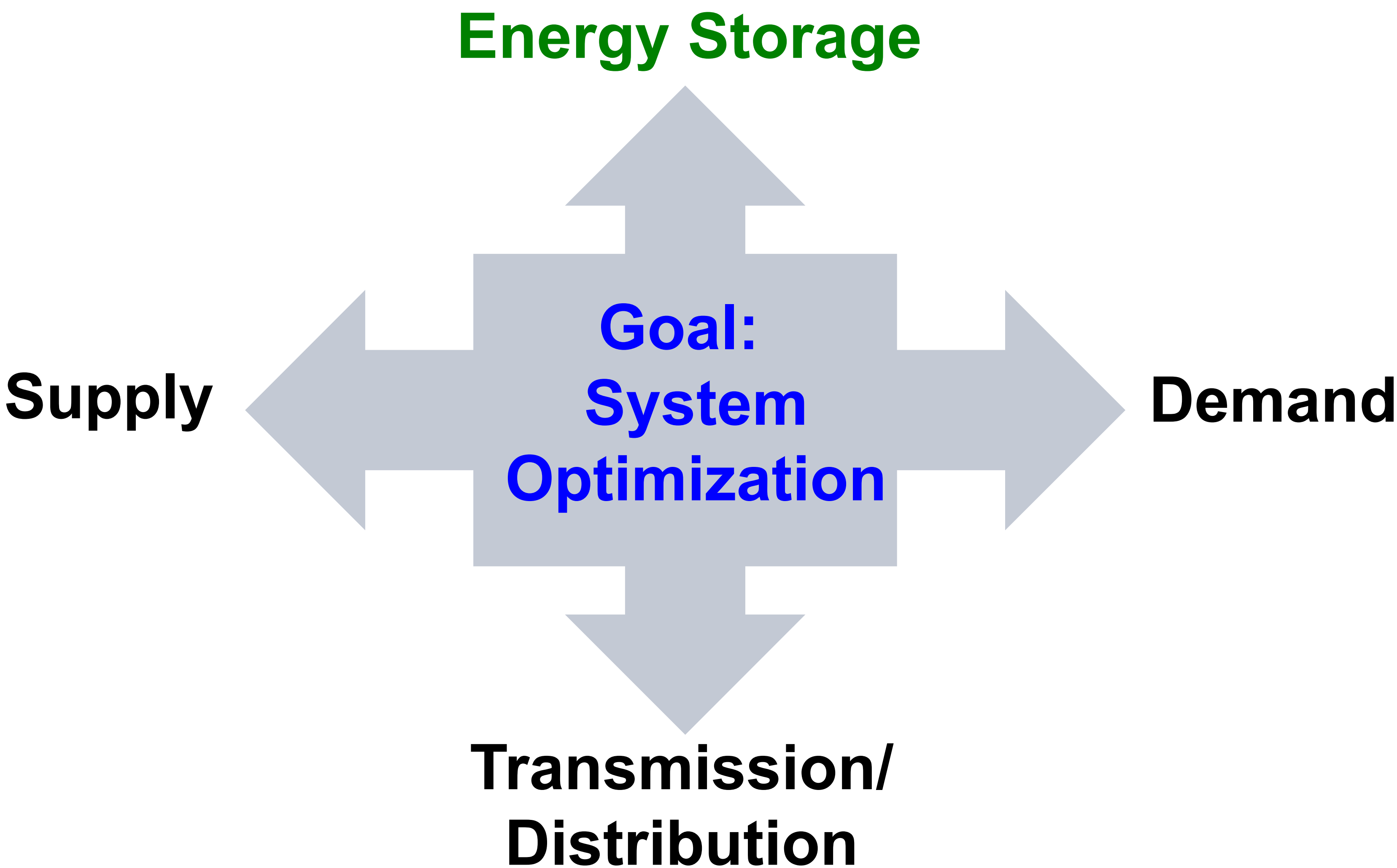
Energy storage is deserving of its own asset class category and immediate energy policy focus



CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

Ideas for how the CEC can accelerate progress …

The CEC is uniquely positioned to establish a vision for storage in California

- Create a 2020 vision for energy storage in California
- Develop and support PIER RD&D plan that supports the resulting vision
- Support incentives to encourage utility procurement of energy storage capacity and services
- Support development of CAISO energy storage tariff for regulation allowing energy storage to bid into regulation markets on a comparable basis that pays for actual performance
- Modify the CEC's siting regulations so that all applications for new power plants, T&D siting corridors include evaluation of energy storage as an alternative
- Add energy storage explicitly to the loading order
- Establish an 'Energy Storage Collaborative'

Energy storage represents a tremendous opportunity for California!

For more information, please contact:

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Strategies for Clean Energy

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Berkeley, CA 94704

jlin@strategen.com

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M 415 595 8301

www. strategen.com

Renewable integration + storage = economic development

Collaborative Project Will Support Renewable Integration

- 5-10 MW 4 hour ‘Energy Storage Station’ to be housed at Pine Tree Wind Farm, LADWP’s wind power facility in the Tehachapi Mountains
- Collaborative partnership between LADWP and BYD, a leading manufacturer of advanced battery technology
- This advanced energy storage project will help balance the integration of wind energy into LADWP’s large generation portfolio; estimated completion date: July 2011

Utilizing energy storage for renewable integration is here today

Other California Energy Storage Regulatory Activities

California's regulatory framework is rapidly evolving to accelerate deployment of grid storage

» CA ISO Stakeholder process for Ancillary Services

» CPUC Self Generation Incentive Program (SGIP)

» CPUC Standard Offer for Permanent Load Shifting (PLS)

» CPUC Smart Grid Deployment

» CPUC Mandatory Default Critical Peak Pricing Tariffs (CPP)

» CPUC Feed in Tariffs with differential rates for renewables coupled with storage

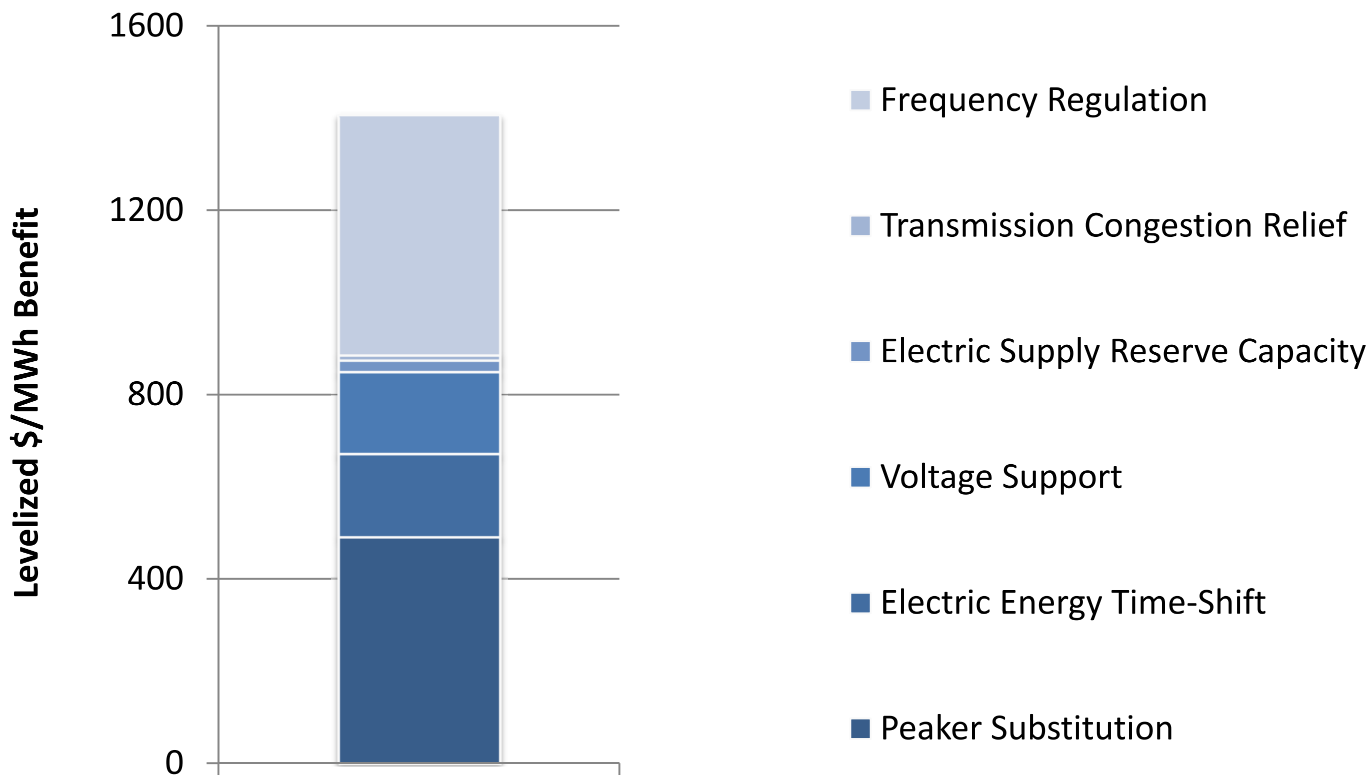
» CARB Renewable Electricity Standard (RES) Implementation

» CEC Integrated Energy Policy Report 2010 update includes storage

Successful passage of the Federal ITC will accelerate deployment significantly

Additional System Benefits of Energy Storage

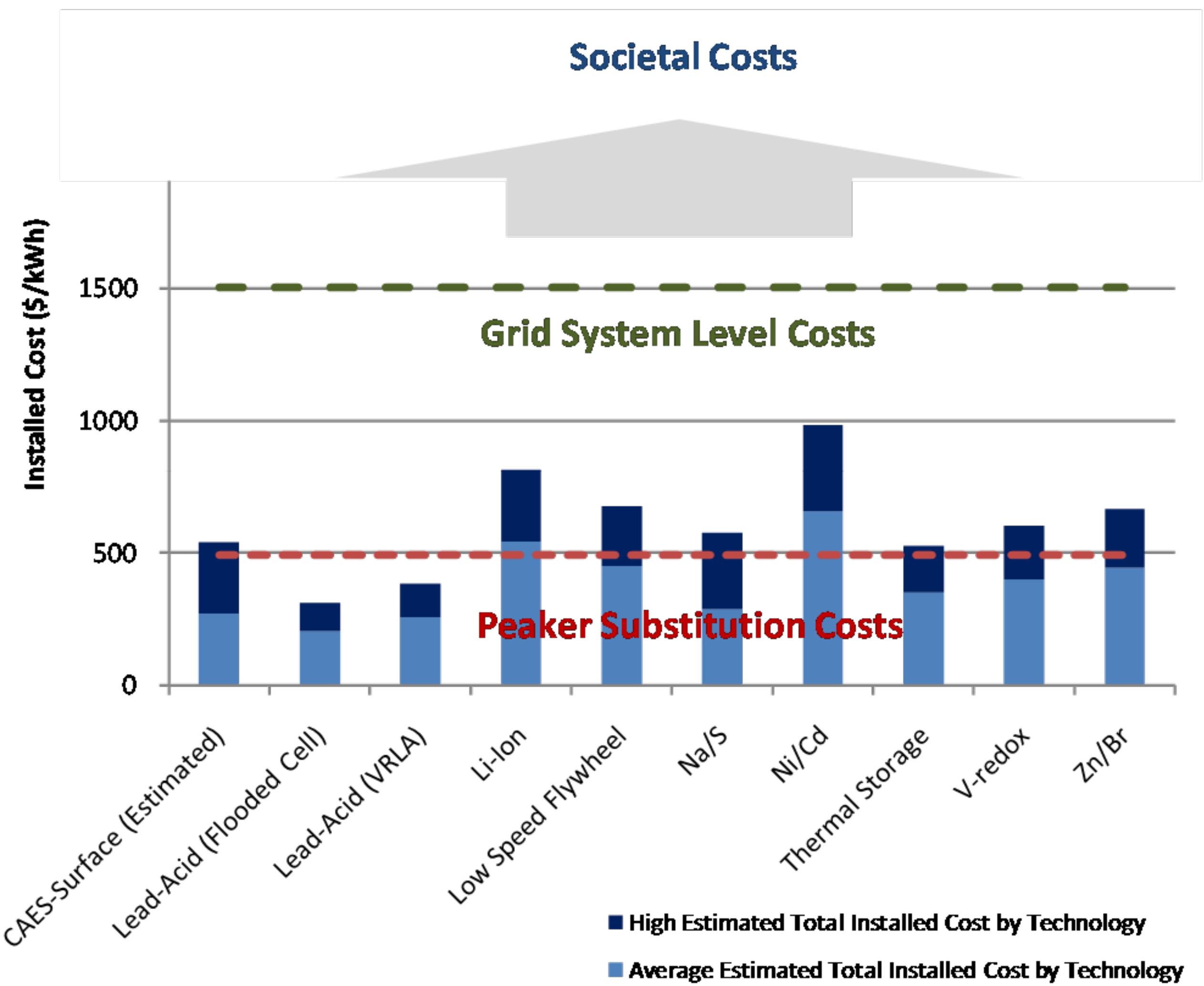
Energy storage provides multiple value streams above and beyond peaker substitution, making the economic case for energy storage even stronger



Source: SANDIA Report SAND2010-0815, Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Jim Eyer & Garth Corey (February 2010)

Energy storage is a cheaper alternative to natural gas peakers – additional benefits of storage

Fossil Fuel Societal, Grid, and Peaking Costs vs. Energy Storage Costs[1,2]



Avoided Costs Realized

Societal Level:

- GHG & Air Quality
- Renewables Integration
- Smart Grid Implementation
- Streamlined Permitting

Grid System Level:

- Electric Energy Time-Shift
- Voltage Support
- Electric Supply Reserve Capacity
- Transmission Congestion Relief
- Frequency Regulation

Peaker Level:

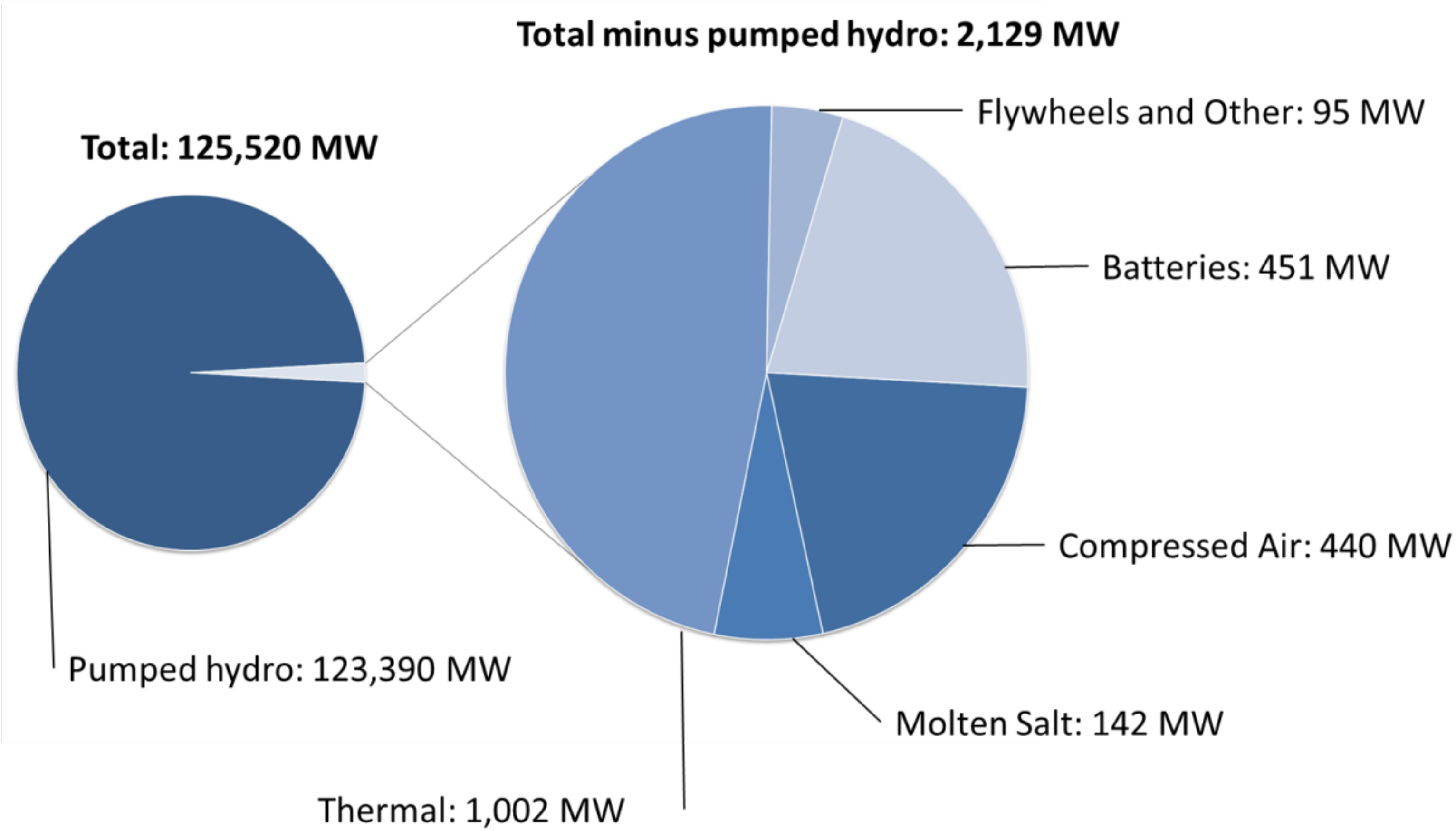
- Peaker Plant Substitution

1) Assumptions: All energy storage technology costs shown are normalized for a four-hour duration; Technology comparison is for modern energy storage systems only, but does not include pumped hydro or high-speed flywheels which are not designed for long-duration peaking applications

2) Source: Average estimated total installed cost estimate from: Sandia Report SAND2008-0978, Susan M. Schoenung and Jim Eyer, Benefit/Cost Framework for Evaluating (February 2008)

The Grid Connected Energy Storage Market is Large …

Estimated Global Installed Capacity of Energy Storage



Source: StrateGen Consulting, LLC research; thermal storage installed and announced capacity estimated by Ice Energy and Calmac.
Note: Estimates include thermal energy storage for cooling only. Figures current as of April, 2010.

… and Growing Fast

- » Top clean tech investment area in 2009: **$320M invested**
- » Key focus of ARRA stimulus funding: **$185M** awarded in 2009 – California received **$74M**
- » Advanced energy storage (AES) capacity will increase by **>100%** (2,128 MW current, announced new capacity of 2,250 MW)
- » New proposals AES projects in California total over **550 MW**
- » GTM Research forecasts AES market to grow by **40%** per annum

Source: StrateGen Consulting, LLC research; thermal storage installed and announced capacity estimated by Ice Energy and Calmac,
Estimates include thermal energy storage for cooling only.
Figures current as of March, 2010.

AB 2514 - Diverse Stakeholder Support

Attorney General (co-source)
Mayor Antonio Villaraigosa
A123 Systems
AIC Labs
Altairnano
Applied Intellectual Council
Balanced Clean Energy Solutions
Beacon Power
Breathe California
CALMAC
California Energy Storage Alliance
CAREBS
Clean Power Campaign
Debenham Energy, LLC
Dow Kokam
ElectronVault
Electricity Storage Association
Enersys
EnerVault
Evapco, Inc.
Fafco
Fluidic Energy
HDR-DTA
Green California
Ice Energy
Independent Energy Producers
Large-scale Solar Association
LightSail Energy
MegaWatt Storage Farm
Mohr Davidow Ventures
Natgun
NGK-Locke
Pacific Housing Inc.
Panasonic
Pearl Street Liquidity Advisors
Polaris Venture Partners
PowerGenix
Primus Power
Prudent Energy
PVT Solar
ReStore Energy Systems
Rockport Capital Partners
Saft America, Inc.
Sail Venture Partners
Samsung SDI America, Inc.
Sanyo
Seeo, Inc.
Sierra Club
The Solar Alliance
South Coast Air Quality Management District
Suntech
Sunverge
SustainX
Velkess Inc.
The Vote Solar Initiative
Union of Concerned Scientists
Wallrich Landi
Xtreme Power

Examples of Projects Eligible Under AB 2514

Batteries

- Electrical energy is stored for later use in chemical form. Existing battery technologies are being improved, and new battery technologies are becoming available.
- Example: 34 MW Sodium Sulfur Battery — 51 MW wind farm, Japan (NGK)

Thermal Storage

- Air conditioners create ice at night, when power rates are low. This stored ice then runs a cooling system during the afternoon, when power costs are highest and the power grid is most stressed.
- Example: 12 kW Thermal Storage — Napa Community College (Ice Energy)

Flywheels

- Flywheels convert electrical energy to kinetic energy, then back again very rapidly. Flywheels are ideal for power conditioning and short-term storage.
- Example: 3 MW Mechanical Storage for Ancillary Services — NE ISO (Beacon Power)

Compressed Air

- Electricity is used to compress air into storage tanks or a large underground cavern. The compressed air is used to spin turbines when electricity is needed.
- Example: 115 MW Compressed Air Energy Storage — McIntosh, Alabama

Pumped Hydro

- Excess electricity is used to pump water uphill into a reservoir. When power is needed, the water can run down through turbines, much like a traditional hydroelectric dam.
- Example: 1,532 MW Pumped Hydro — TVA's Raccoon Mountain

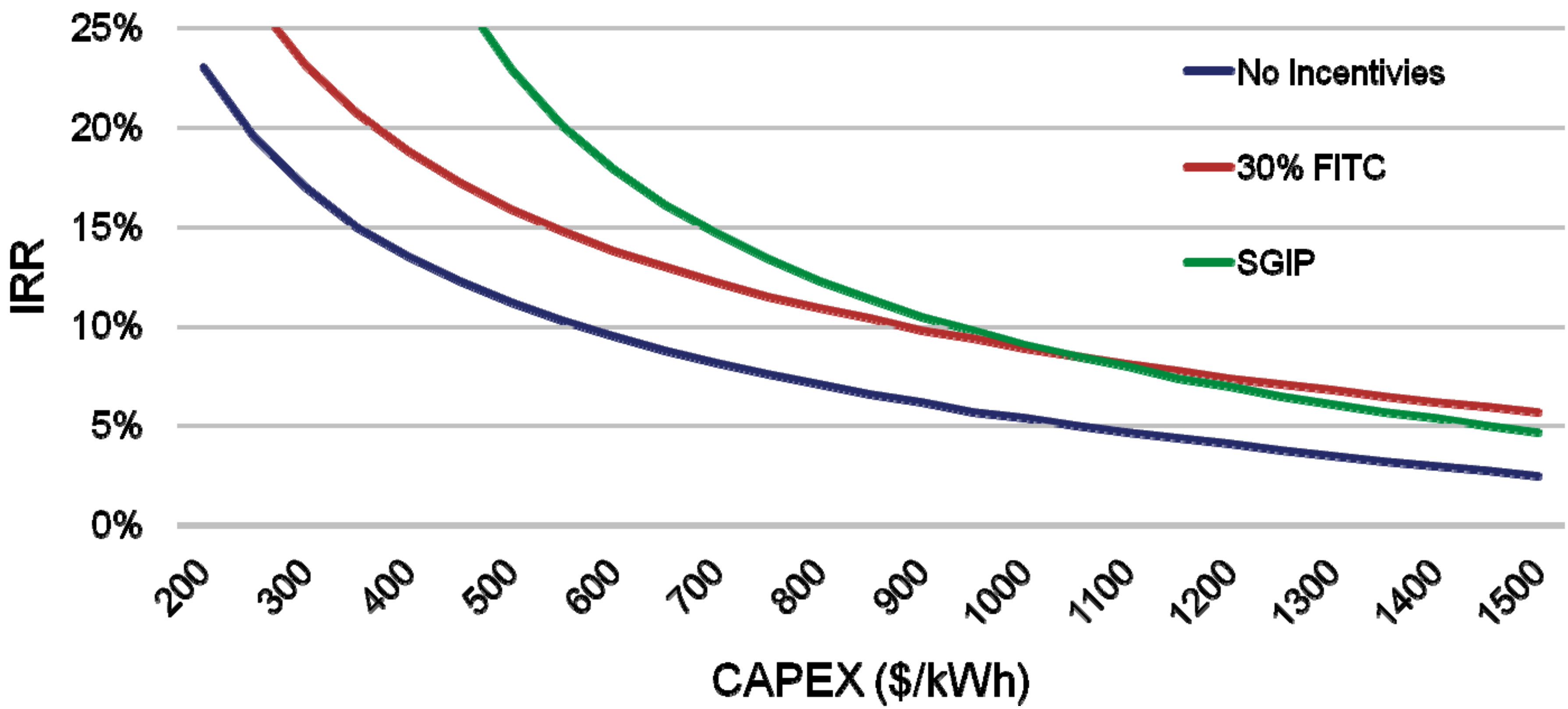
CAISO Ancillary Services Update

1. CESA actively participating in Non-Generator Resources in CAISO Ancillary Services Markets – Stakeholder Process
2. Issue paper published September 2009 – intended to comply with FERC Orders 890 and 719 comparability standard
3. CAISO Board approved staff proposal in March 2010:
   - Resource type restrictions removed
   - Minimum rated capacity reduced to 500 kW
   - Minimum contiguous energy requirement reduced from 2 hours to 30 minutes
   - Measurement starts once resource reaches awarded energy instead of 10 minute ramp equivalent
4. Regulatory Energy Management (REM) proposal, supported by CESA, would allow 15 minute resources to participate in day-ahead market
5. Strawman REM proposal will be presented to senior management this month (November 2010)

SGIP impact: distributed storage value proposition - IRR net of SGIP incentives ($2/W)

CAPEX & Incentives have a significant impact on end-customer returns

IRR vs. CAPEX for Various Incentive Regimes



Permanent Load Shifting Incentives are coming…

Via D.09-08-027, the CPUC ordered California utilities to study use of a ‘standard offer program’ for permanent load shifting (PLS)

What is PLS?

- Shifting energy usage by one or more customers from one time period to another on a recurring basis
- Storing energy generated off peak and using it to support electric load on peak
- Value is captured for ratepayers through energy arbitrage and demand charge capture … and, potentially, incentives

How is PLS different from DR?

- PLS is not dispatched on a day-ahead or day-of basis
- PLS doesn’t respond to short term price fluctuations
- Eligible Storage Examples:
  - Battery storage
  - Thermal energy storage

Utility study of PLS must be completed by 12/1/10

CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

A123 SYSTEMS

Applying Large Scale Li-Ion Energy Storage Technology to Support Renewable Integration and Grid Services

Technologies to Support Renewable Integration

IEPR Staff Workshop , California Energy Commission

November 16, 2010

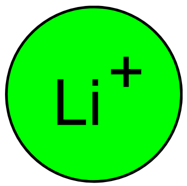
A123 Systems, Inc.

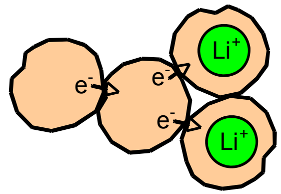
A123 SYSTEMS

A123 Systems is a leading U.S. developer and manufacturer of advanced high power, safe and long-life lithium-ion energy storage solutions for next-generation applications in the transportation, electric grid and consumer markets

- Corporate headquarters: Watertown, Massachusetts
- 1700+ employees worldwide
- Mass producing millions of batteries per year
- >1,000,000 square feet of manufacturing facilities in China, Korea and United States
- Investing ~$1B in capacity (2009 to 2012)
- >30MW of grid-connected systems deployed

Lithium Ion Nanophosphate Technology

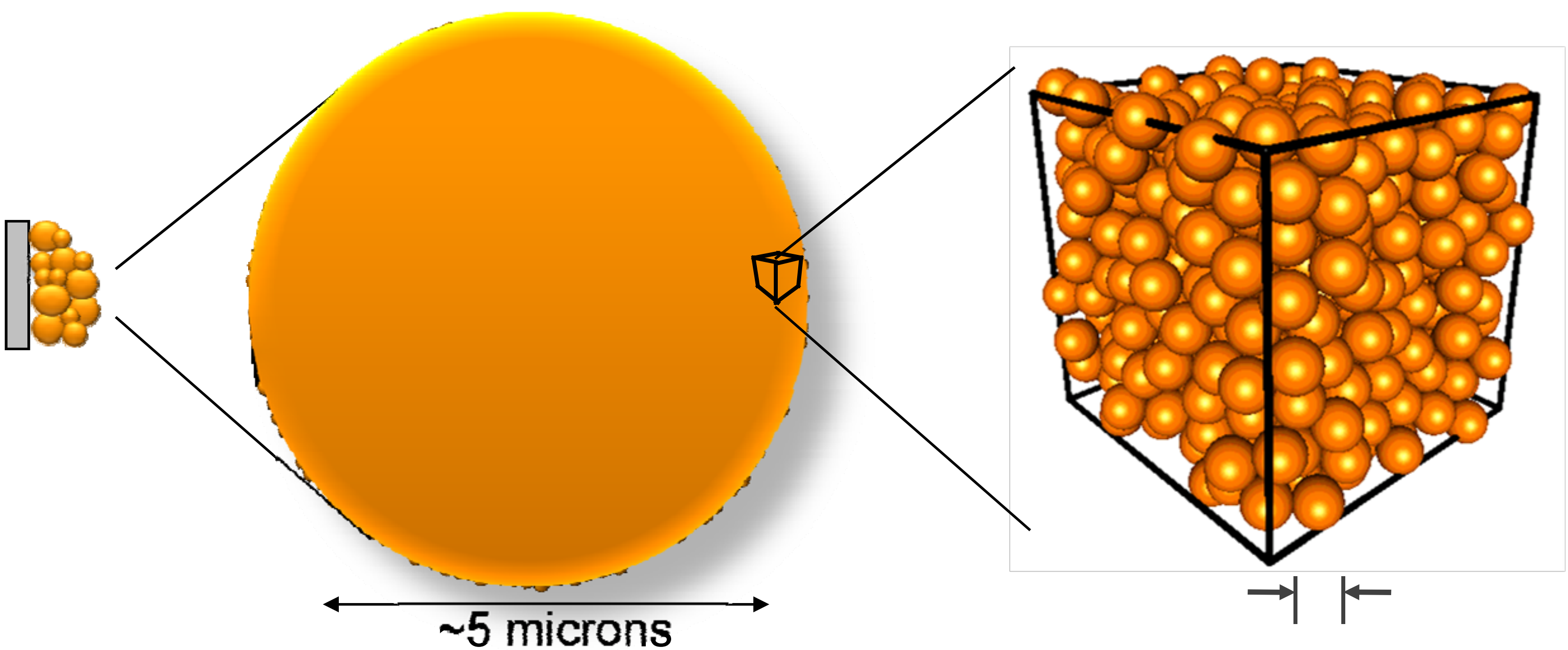




The addition of dopant significantly increases rate capability

High Contact Area

Low Internal Impedance



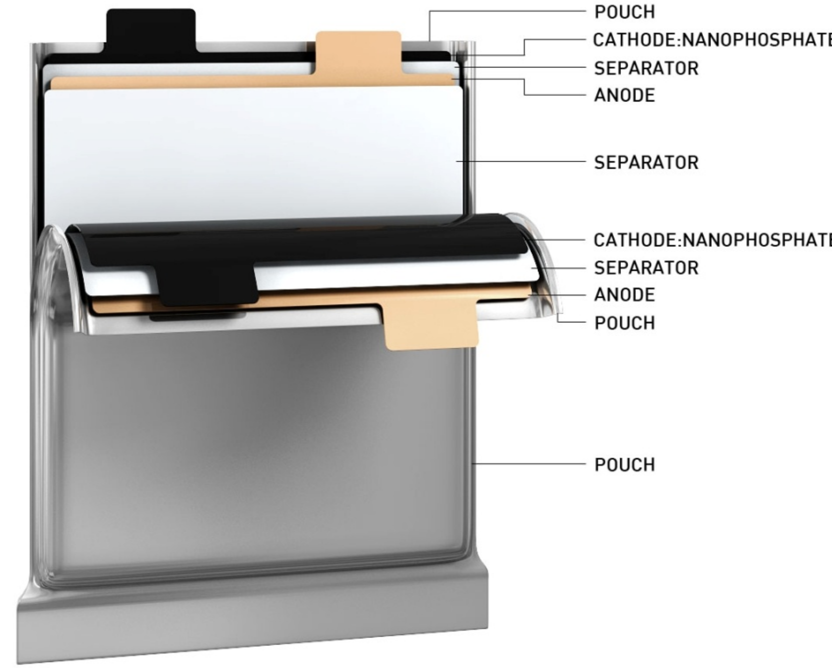
A123 Nanophosphate™ Key Characteristics

A123 SYSTEMS

Power	• Wide product portfolio with industry leading power and energy • For high energy applications: 140Wh/kg with 3000W/kg • For medium power applications: Various designs • For high power applications: 90WH/Kg with 5000W/kg
Safety	• Safest Li Ion chemistry in the market, validated by National Labs and multiple automotive customers
Life	• 20 year calendar life • Excellent Watt Hour throughput and cycle life

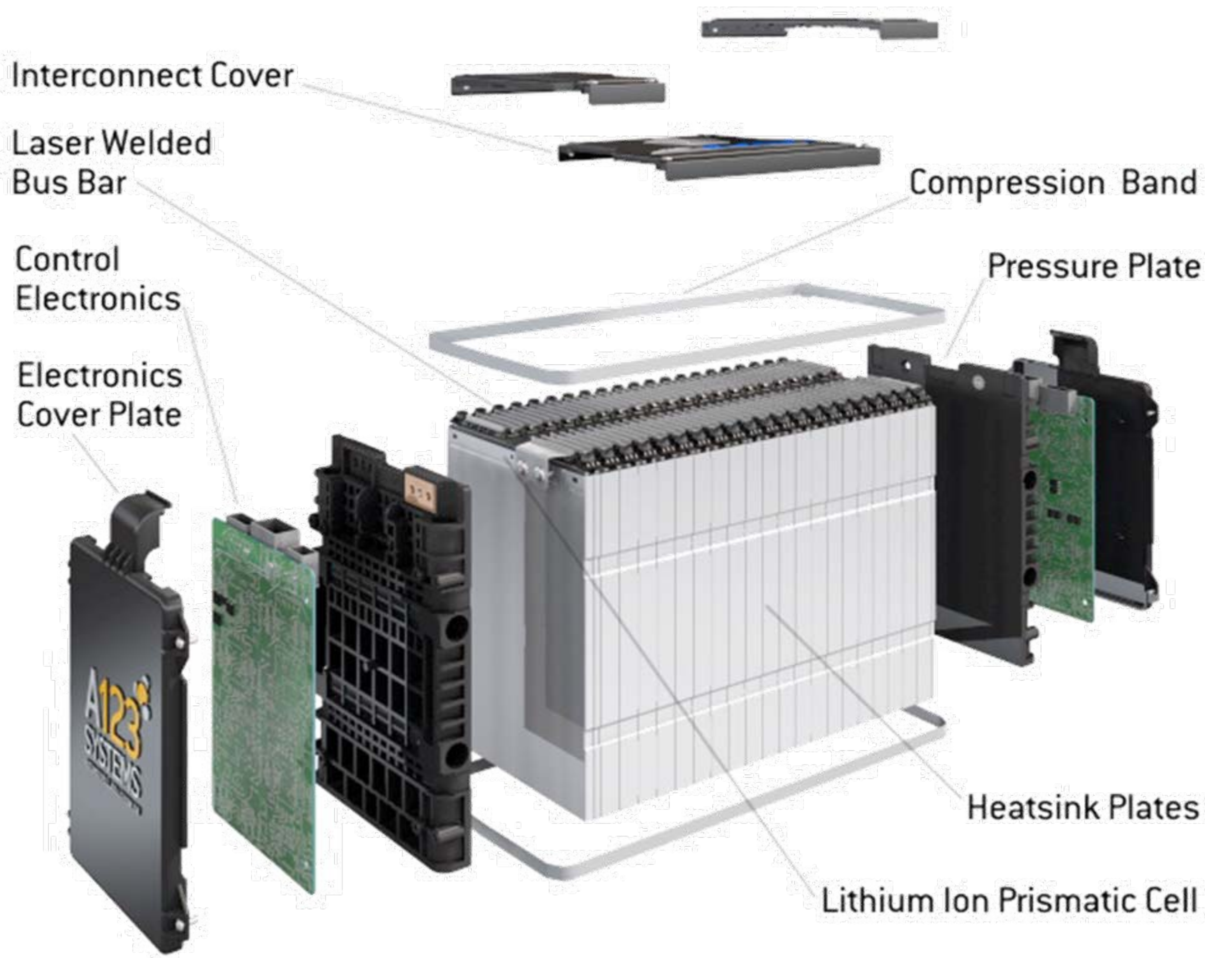
A123 Nanophosphate^{TM} Battery Cells

Cylindrical and Prismatic Form Factors



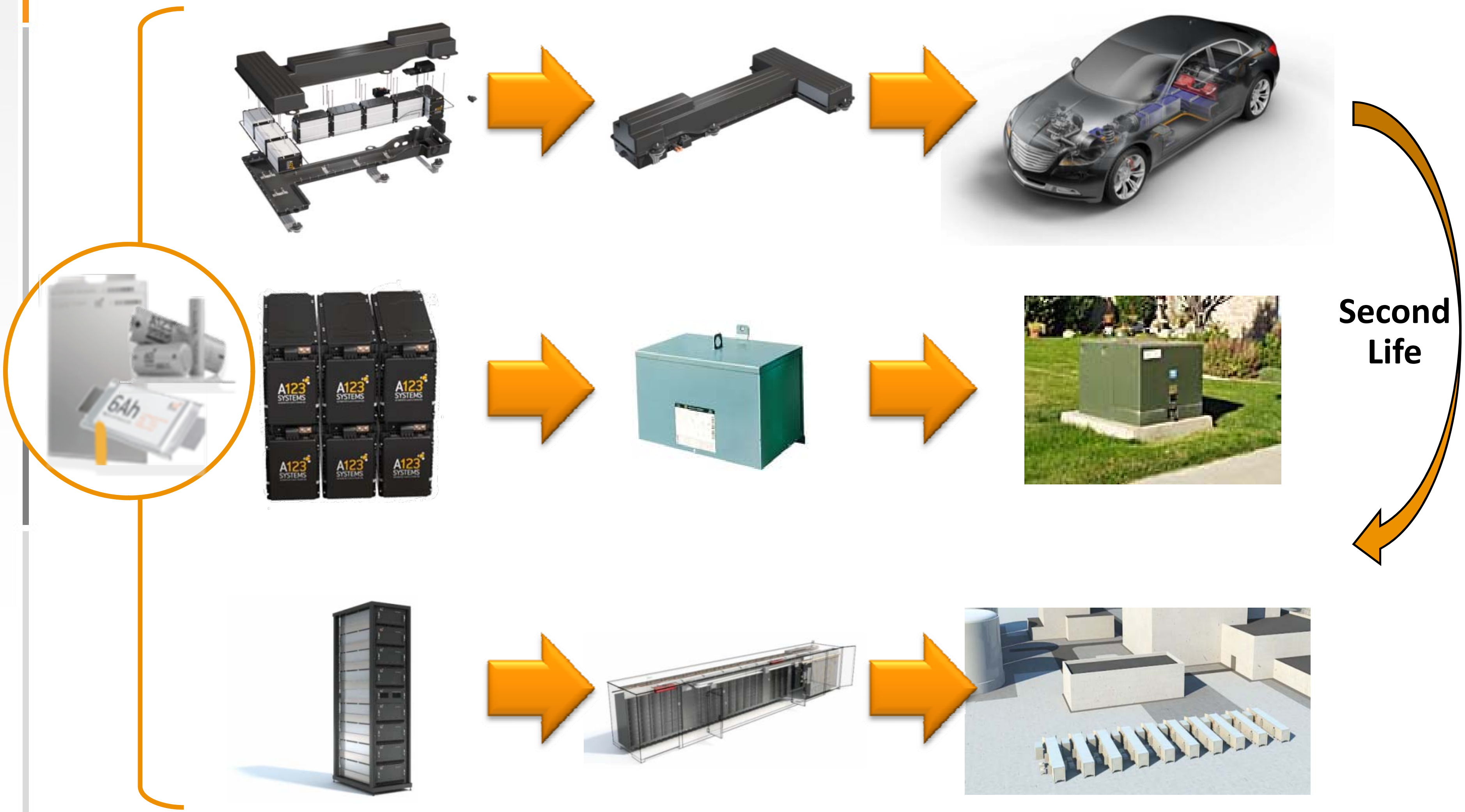
A123 Modules

Prismatic Building Block for Systems



Common Building Block Architecture

Modular architecture for rapid prototyping and deployment



First ‘Industrial Scale’ A123 Deployment in 2008 for AES at Huntington Beach CA

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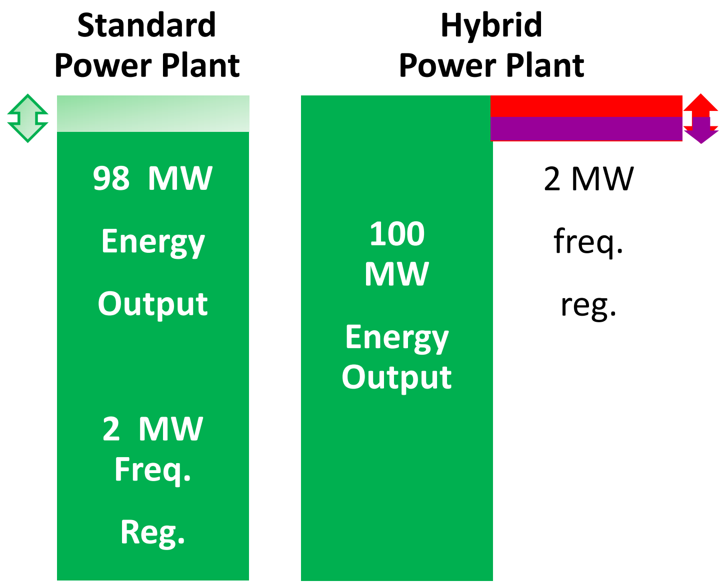
Energy Storage for Frequency Regulation Service

The Challenge:

- Thermal plant encumbered by regulation service operates less efficiently, has increased O&M costs and higher emissions



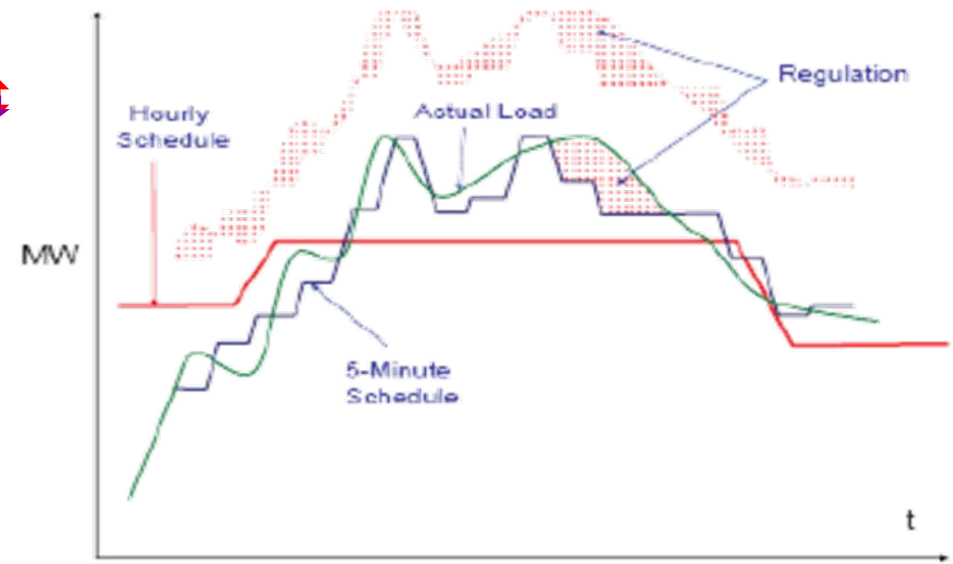


Fig. 4, CAISO's Regulation Requirement Illustration[1]

The Solution:

- A123 2MW-Modular system for Regulation service: freeing up thermal generation to deliver more useable energy, add an additional revenue stream, and lower emissions

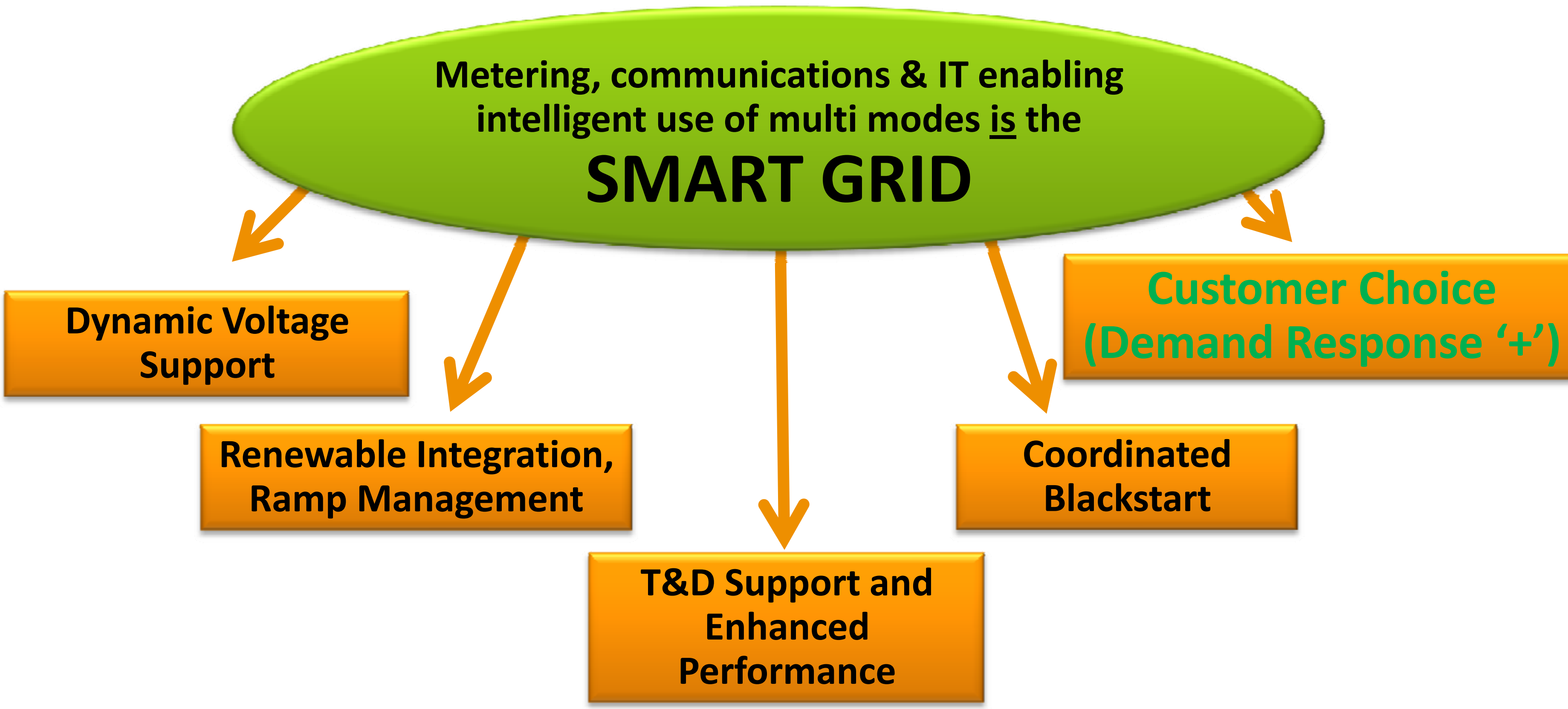
Extending Early Field Experience

A123 is Leveraging Smart Grid

A123 SYSTEMS

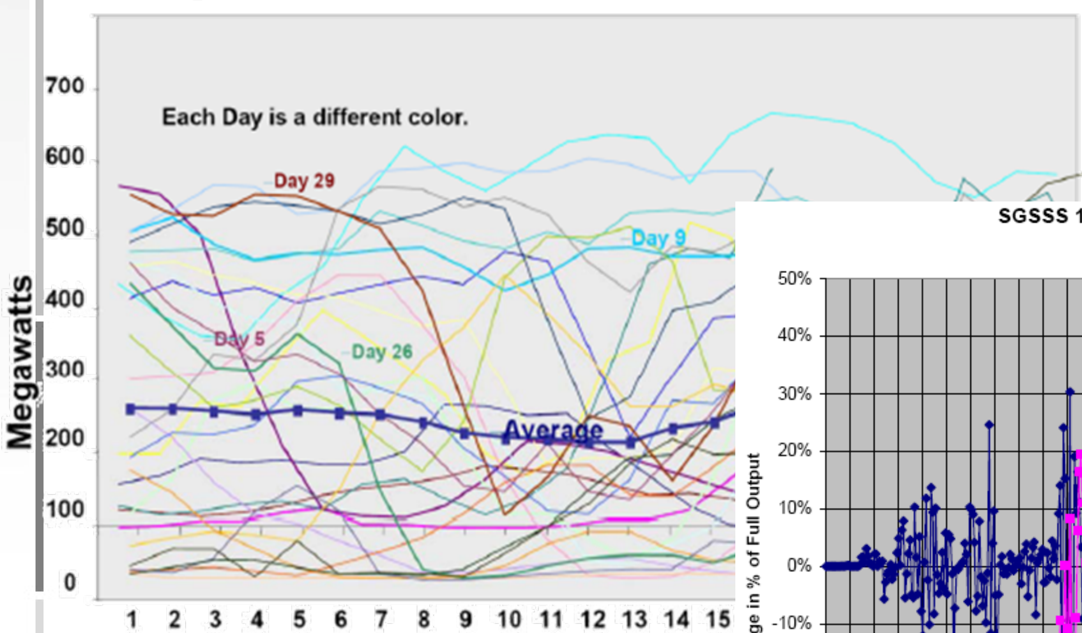
Today, A123's modular GBS is used primarily in Frequency Regulation & Spinning Reserve service

Next, leverage Smart Grid and GBS functionality (speed & control) to deliver additional operating modes of value

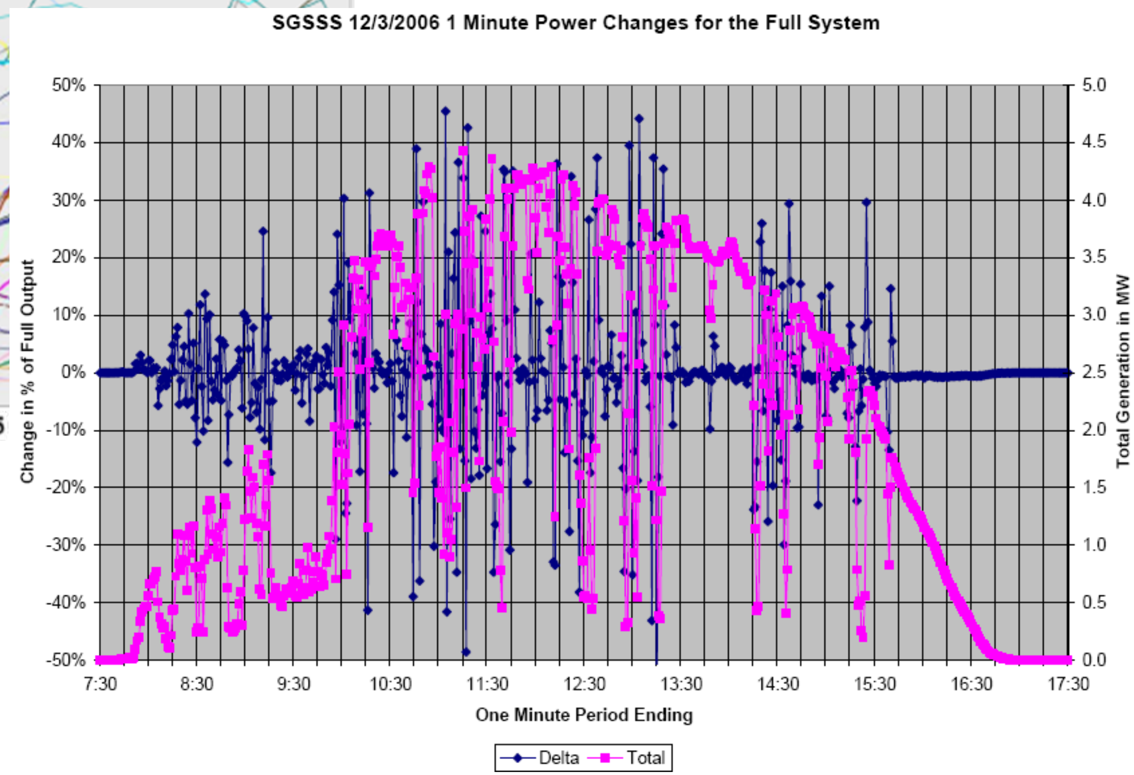


Wind Challenge: Persistent Cycling Intermittency
PV Challenge: Infrequent Binary Intermittency

Wind Production (CA)



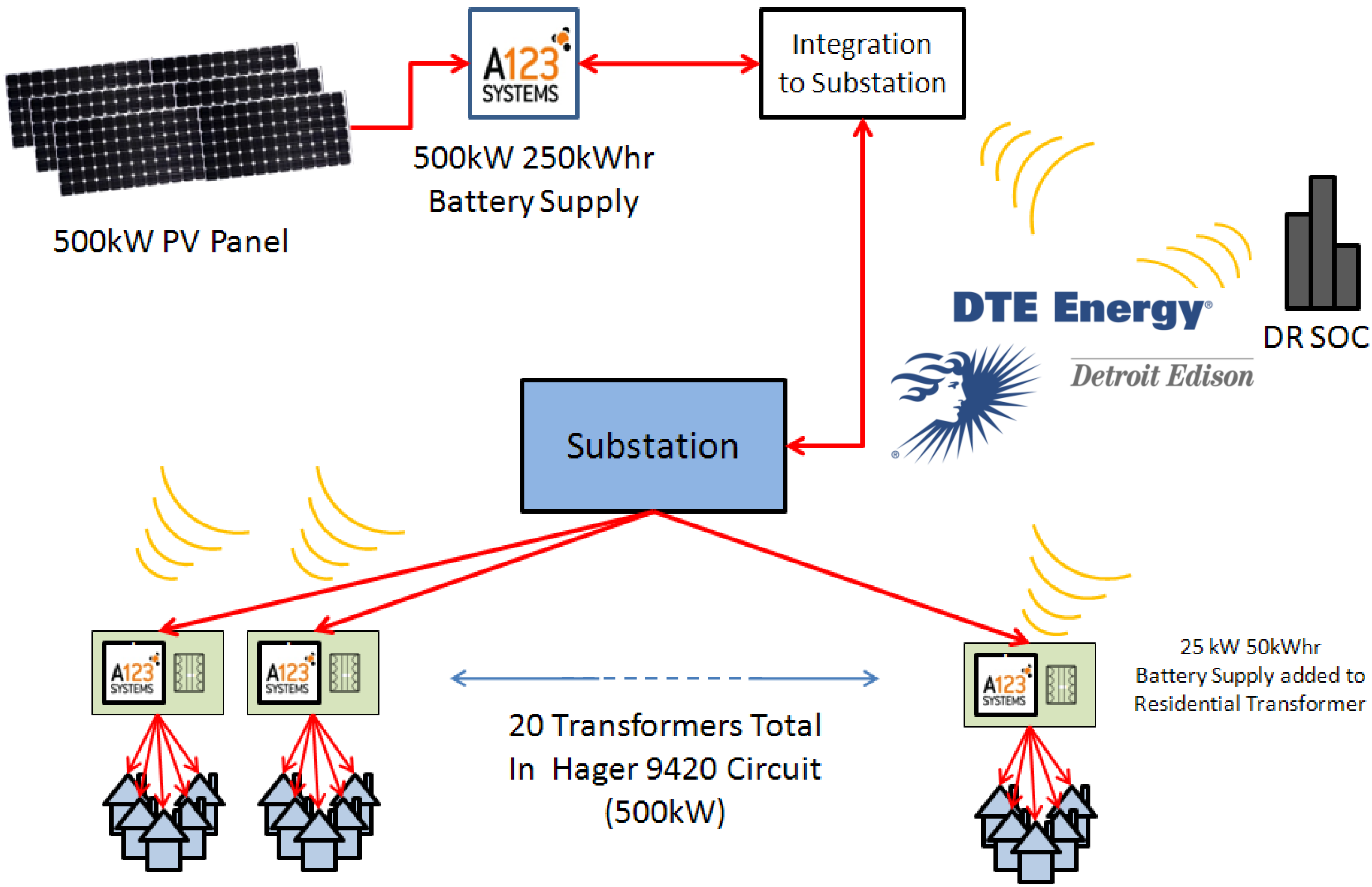
PV Production (AZ)



Source: CAISO and TEP

Wind Integration: DoE Smart Grid Storage Project

Detroit Edison & A123 Smart Grid Storage Project



500 kW PV/Battery Supply	+	500 kW Residential Battery Supply	=	1.0 MW Total CES

DTE and A123 Smart Grid Storage Project

Smart Grid Infrastructure Enabling Multi-mode operation

Demonstration Items:

1. **Frequency Regulation:** (DR-SOC dispatch, retransmit AGC from MISO)

2.a **VAR Support** : (local control, PF management*)

2.b **Voltage support:** (local control, meet utility v-schedule)

3.a **PV output shifting:** (Local control, Time of day)

3.b **PV output leveling:** (local control ,ramp management)

4. **Peak Shaving/Management**

- 4.a Grid support: (DR-SOC dispatch, 'N-1')
- 4.b Distribution circuit peak shaving: (DR-SOC dispatch or schedule)
- 4.c Customer peak shaving: (local control, demand charge mngt)

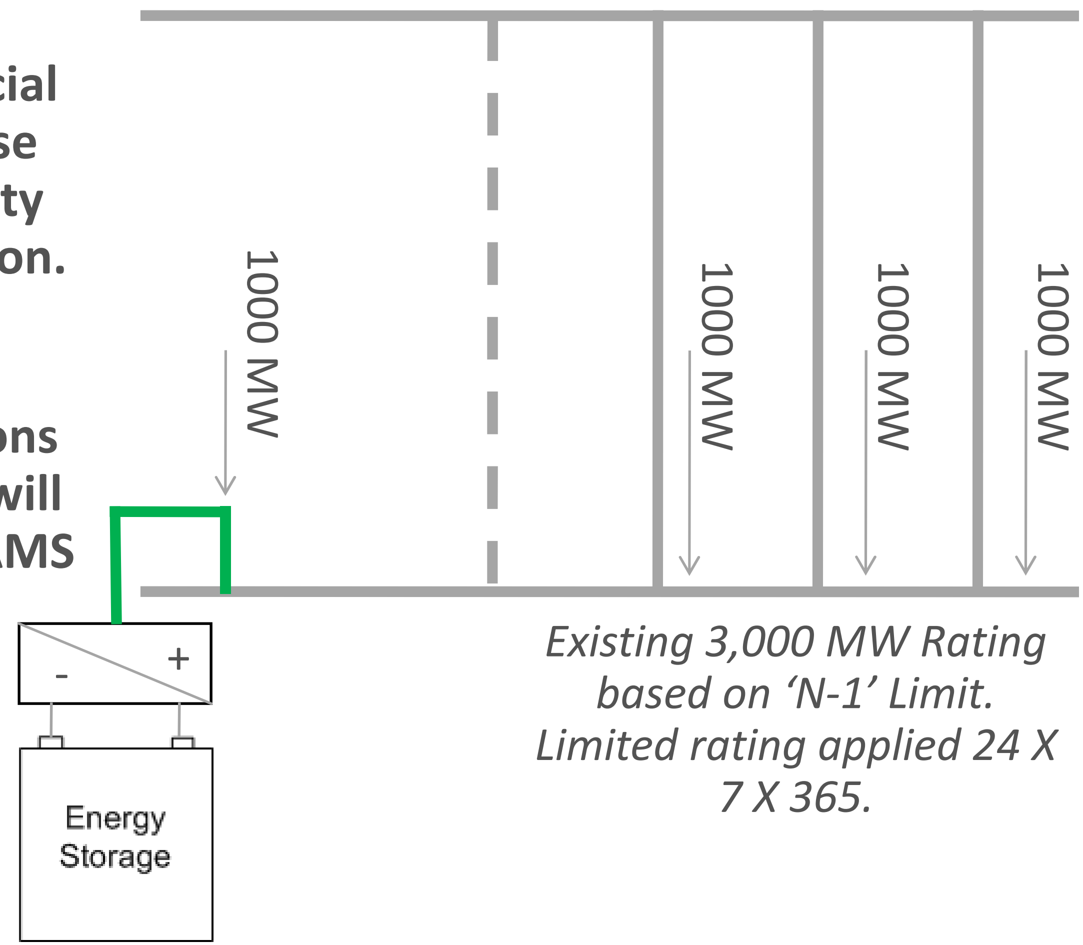
5. **Islanding:** Control schema development for intentional islanding

Further Extending Functionality and Scale for ‘T’ Applications

Storage to Release Encumbered 'T' Capacity
SGSS and Smart Protection Schemes

Storage integrated with Special Protection Scheme to release existing transmission capacity encumbered by 'N-1' limitation.

Other control implementations for grid-supportive services will leverage increased use of WAMS



Existing 3,000 MW Rating based on 'N-1' Limit. Limited rating applied 24 X 7 X 365.

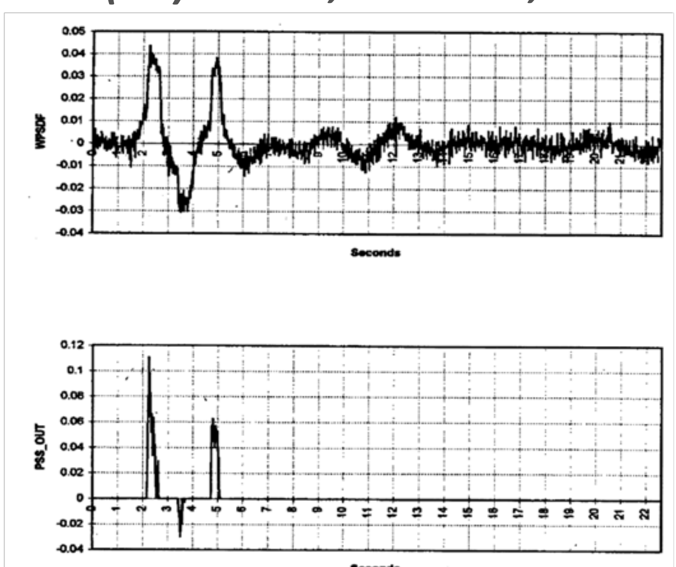
30 minute duration allows

time for area re-dispatch and inter-area adjustments

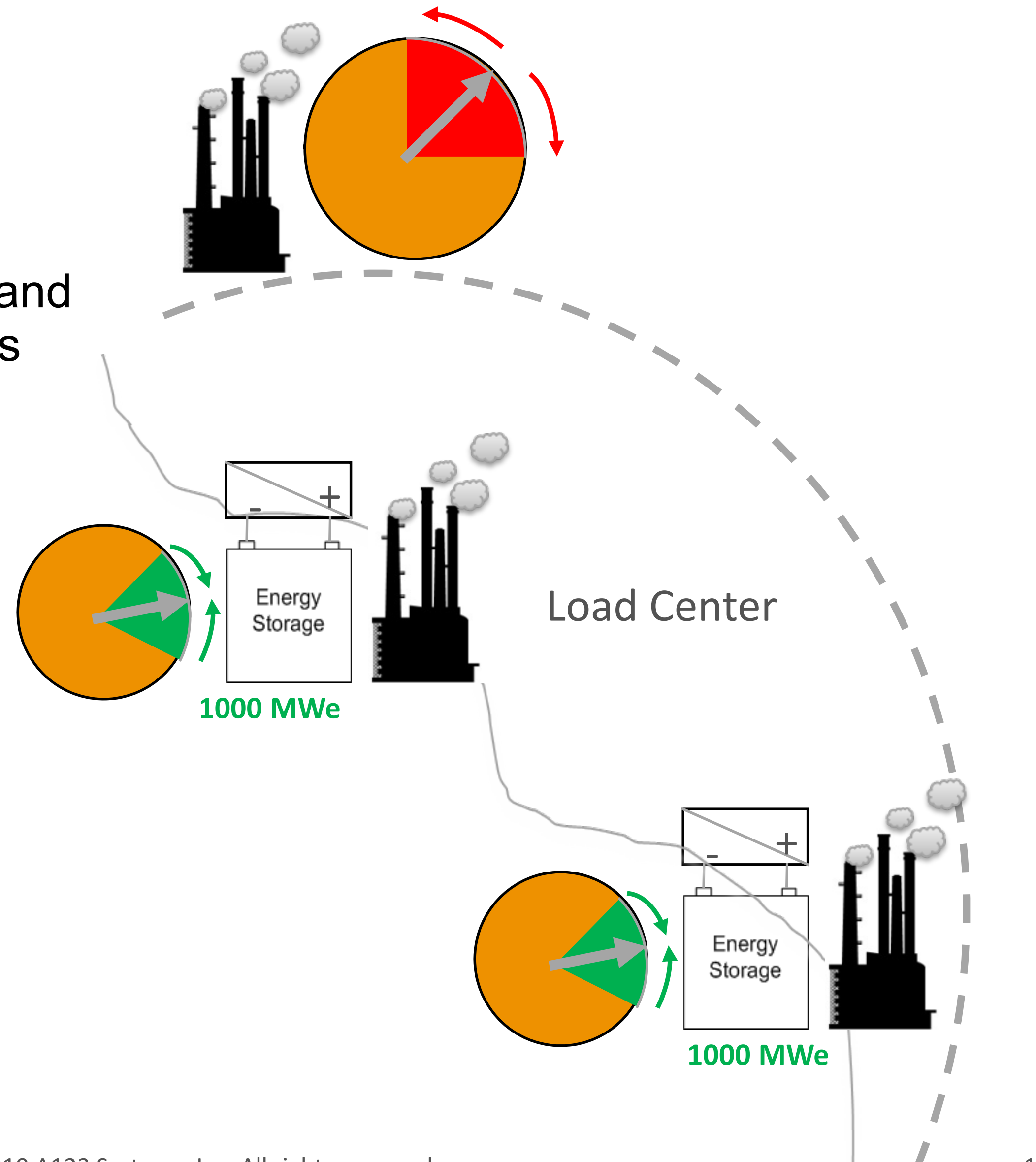
Storage for Increased Grid Stability
SGSS and PMU's for Smart WAMS

PMU-equipped SGSS Detect and Damp Inter-area Oscillations

(GE) ES-PSS, In Action, 1994



Source, SCE, EPRI



A123 Systems

Game Changing Technology

Speed of Innovation

Production and Field Proven

Complete Solutions

Thank You!

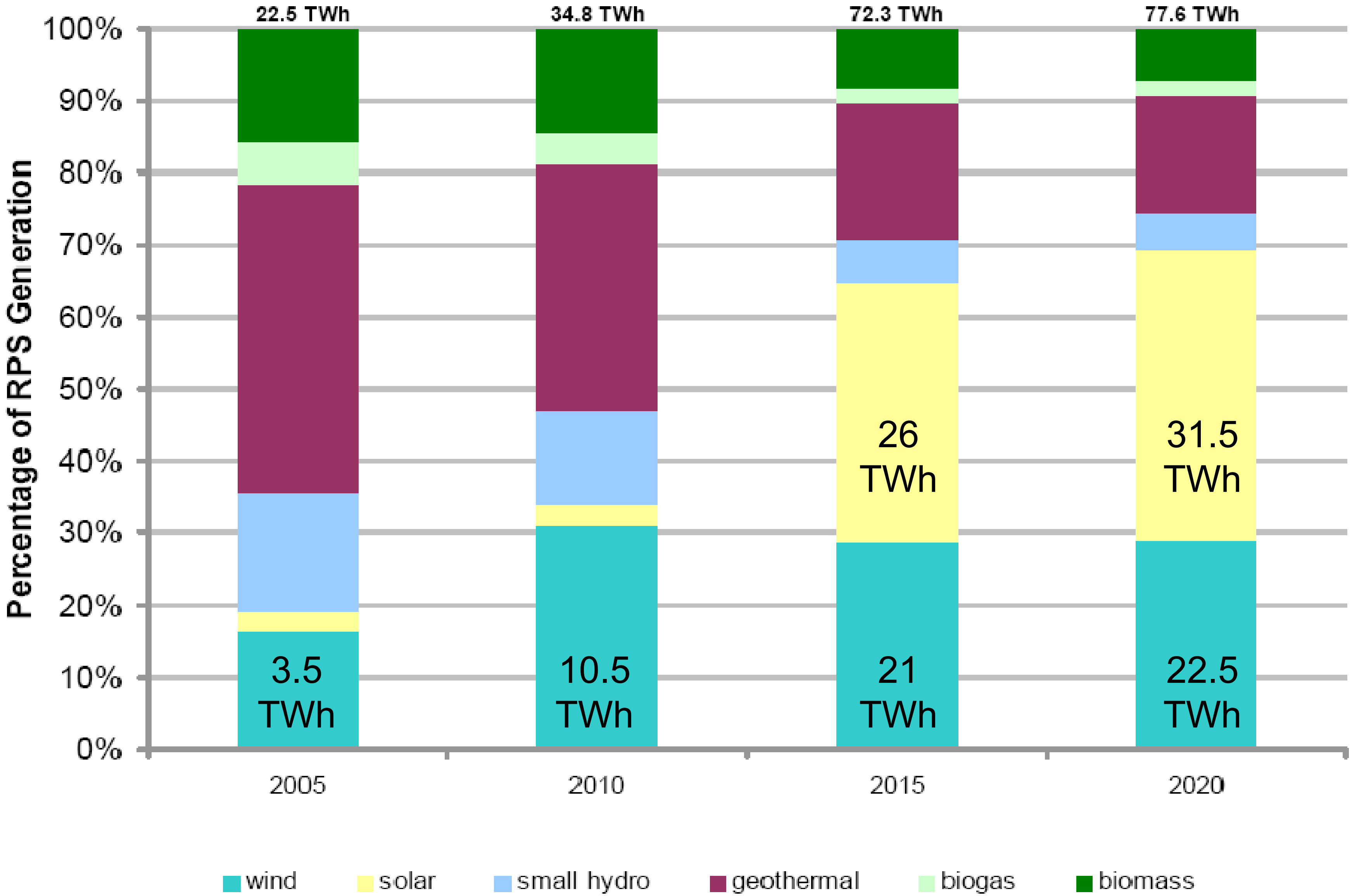
cvartanian@a123systems.com

Applying Large Scale Energy Storage to Support Grid Operations (Sodium Sulfur Battery and Compressed Air Energy Storage)

Jon Eric Thalman, PG&E
Hal La Flash, PG&E
Kevin Swartz, PG&E
Robert Schainker, EPRI Team Member

November 16, 2010

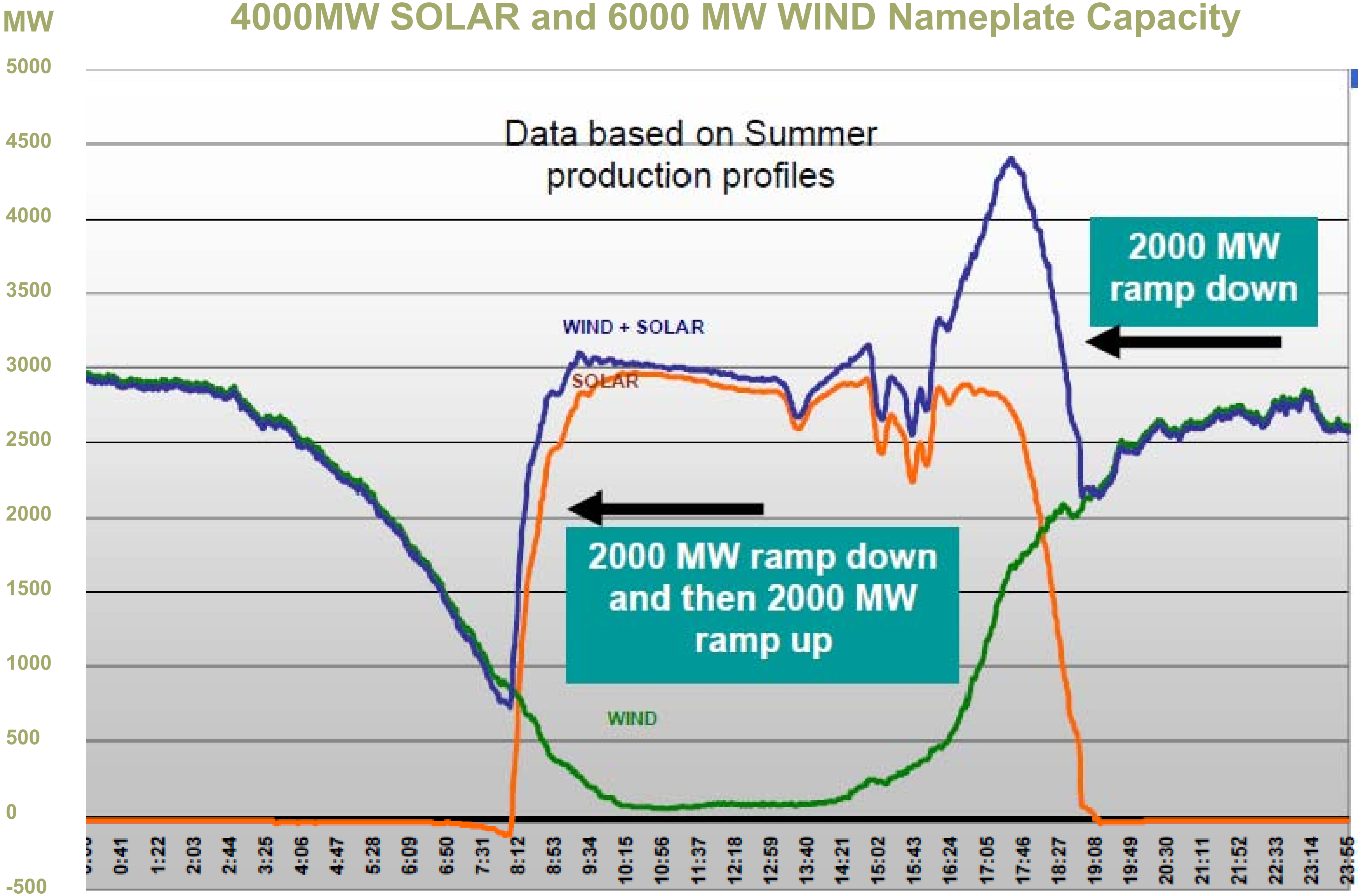
Renewable Resource Mix Projections



Source: California Public Utilities Commission, July 2009

Projected Wind and Solar Ramp Rates

4000MW SOLAR and 6000 MW WIND Nameplate Capacity

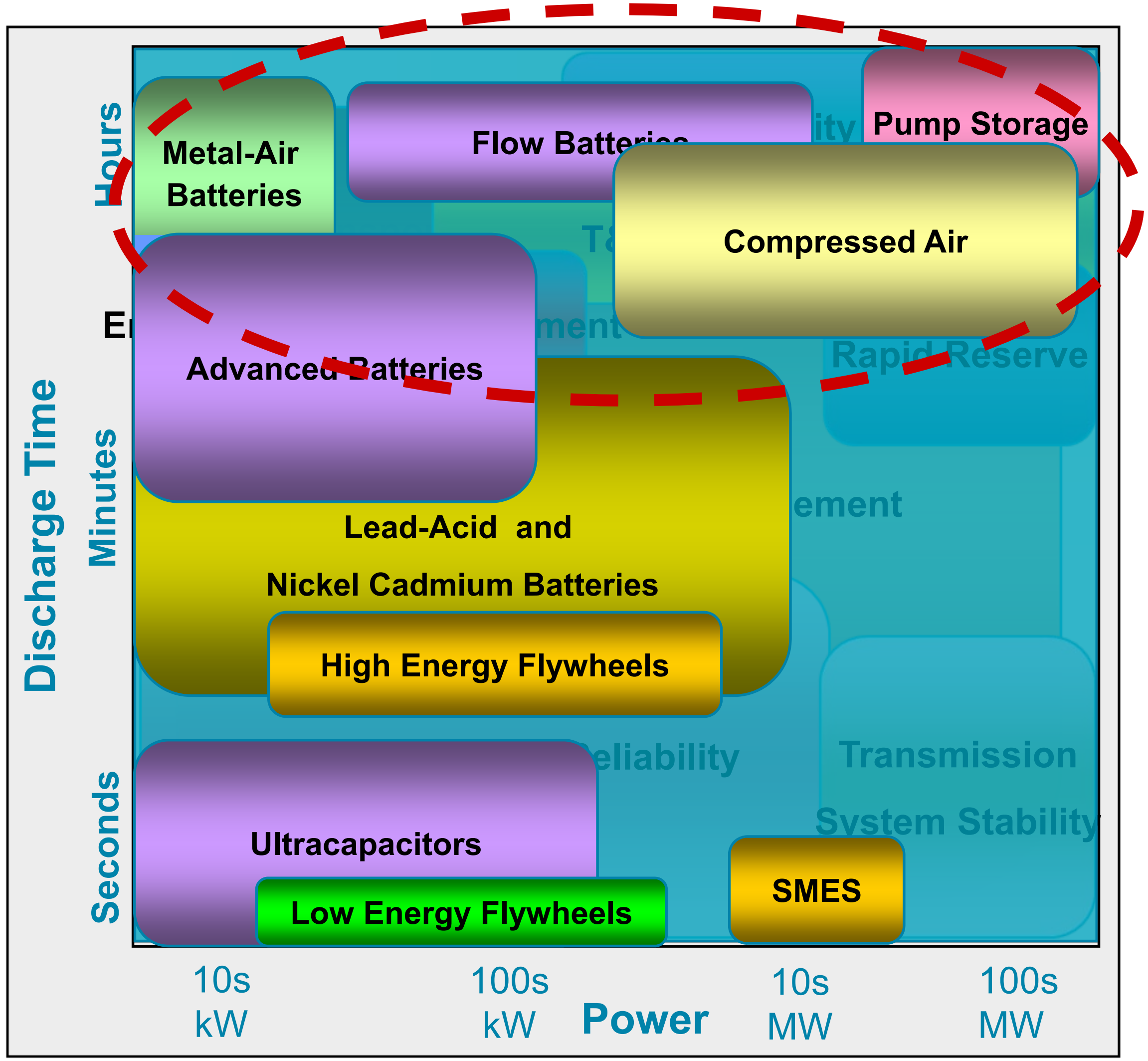


Source: CAISO

Energy Storage Technologies Analyzed
(Large Scale Energy Storage to Support CAIS Grid Operations)

The Only Commercially Available Large Scale Energy Storage Technologies Are:

- Pumped Hydro
- Compress Air
- Sodium Sulfur Battery Systems
  (If use 100's of battery modules)



(All Boundaries Of Regions Displayed Are Approximate)

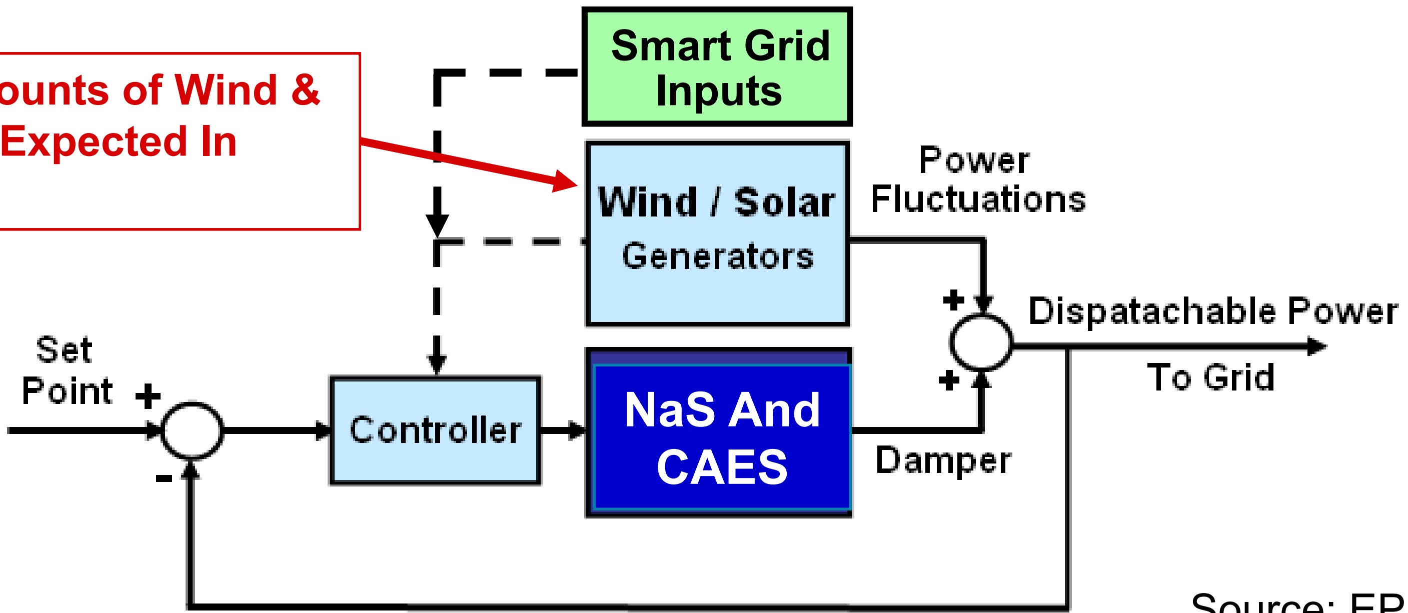
Source: EPRI

Problem: Wind / Renewable Plants Produce Power Output Oscillations Or Provide Power When Not Needed, Which Limits Their Value

Solution:

Deploy Electric Energy Storage Shock Absorber Plant, Which Is Sized and Controlled To Reduce Load Leveling, Ramping, Frequency Oscillation and/or VAR Problems

Large Amounts of Wind & Solar Are Expected In California



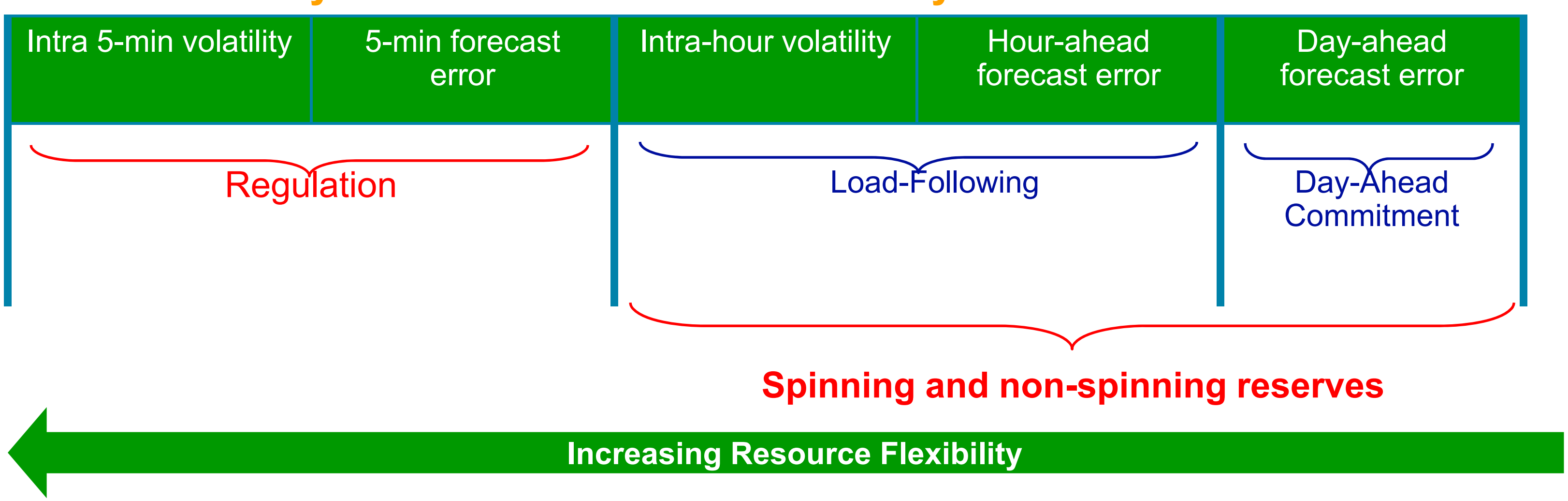
Source: EPRI

Resources Needed to Provide Ancillary Services

Ancillary services include:

- Regulation Reserves (Reg Up/Down): resources that can increase or decrease output instantly to continuously balance generating resources and demand
- Spinning Reserves: resources that are running (i.e., “spinning”) with capable of ramping within 10 minutes and running for at least two hours
- Non-Spinning Reserves: resources that are not running, but capable of being synchronized to the grid within 10 minutes, and running for at least two hours

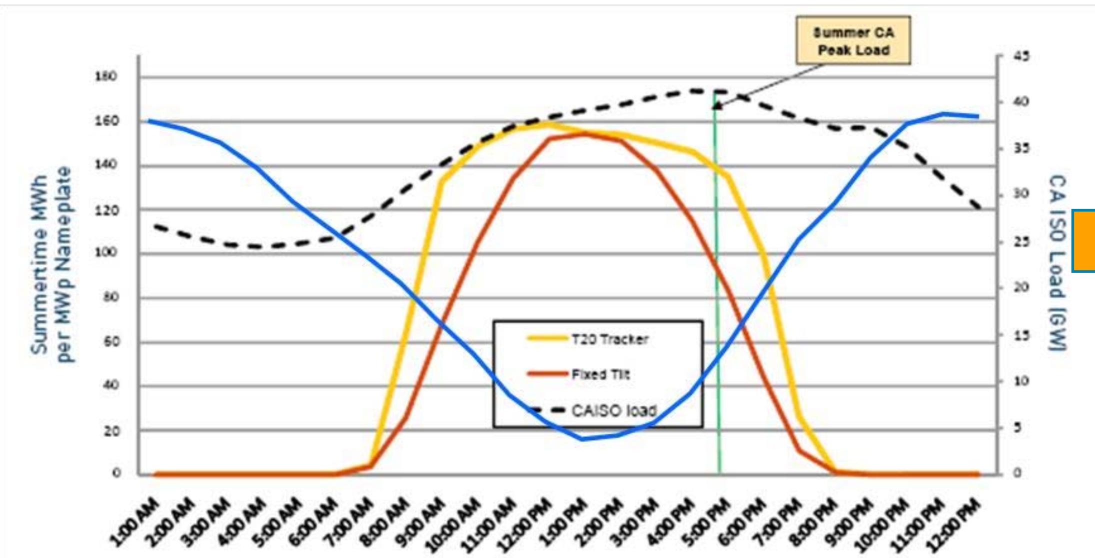
Ancillary services address load volatility and forecast errors



"Resource Adequacy" Required for Renewables Support

Renewable intermittency and mismatch with peak load contribute to the low RA values assigned to renewable generation

Peak Load Versus Renewable Generation Profile



Resource	RA Value
Nuclear	1.00
Natural Gas	1.00
Geothermal	.90
Concentrating Solar Thermal	.82
Solar PV	.57
Wind	.11

RA values are CAISO assigned and may not reflect actual contribution to meeting peak load.

Higher intermittent renewable penetration requires procurement of greater total generation capacity to meet forecast peak reliability need

PG&E NaS Battery Plant: Overall Project Description

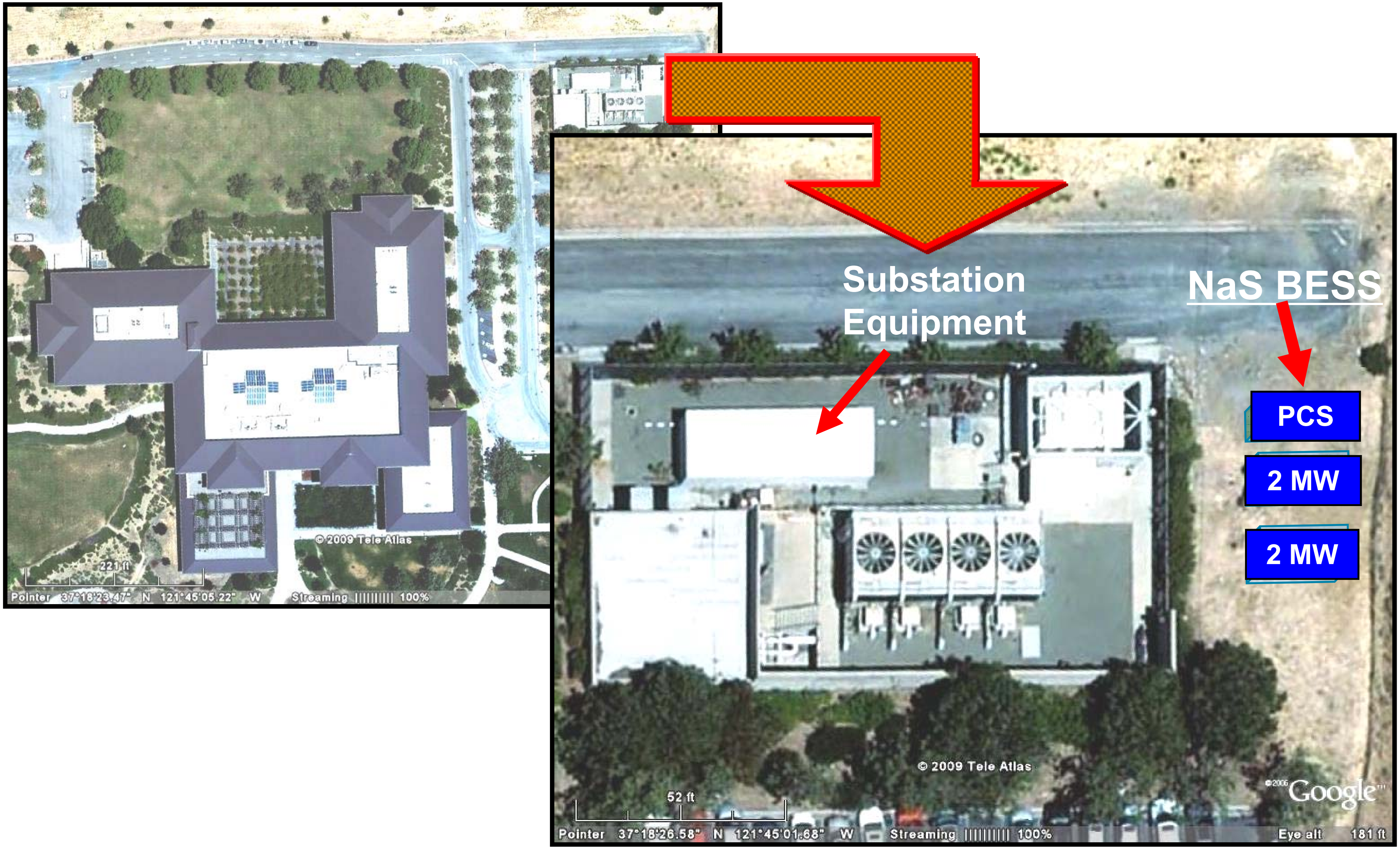
- 4 MVA – 7 Hour Plant
- Partners
  - CEC – Co-Sponsor
  - EPRI – Monitoring and Performance Analysis
  - NGK – NaS Battery Manufacturer
  - S&C Electric - Turn-key Contractor
  - Hitachi – Customer Site
- Support from CEC, CPUC, and DOE
- Expected Operational Date: 2011

PG&E NaS Battery Plant

Project Objectives

- Reliability Improvement
- Load Shaping
- Renewables Integration
  - Grid Optimization
- System Operations
  - Ancillary Services
  - Demand Response
  - Black Start

Hitachi Plant Substation, San Jose, CA



PG&E Compressed Air Energy Storage (CAES) Plant: Overall Project Description

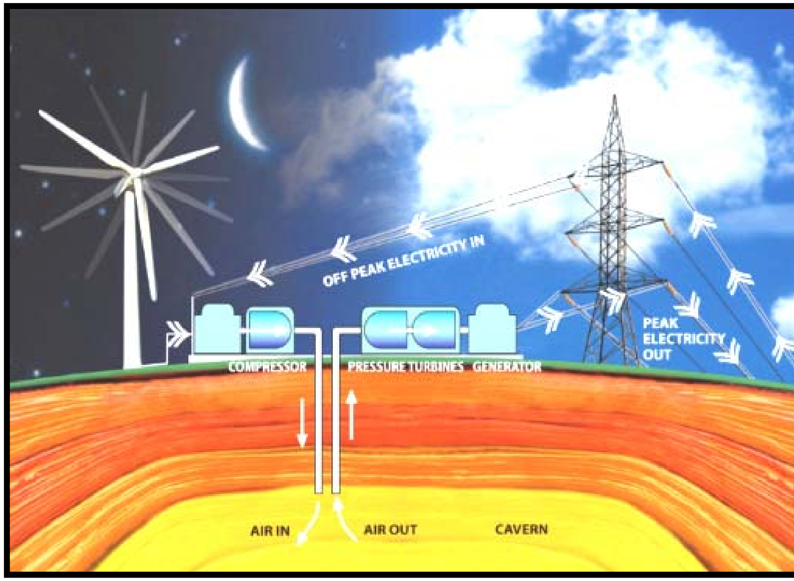
- 300 MW – 10 Hour Plant
- Partners
  - DOE, Co-Sponsor
  - CEC, Co-Sponsor
  - EPRI, Monitoring & Performance Analysis
  - Support from DOE, CEC, CPUC, Vendors
- Expected Operational Date: 2017

PG&E-DOE-EPRI Compressed Air Energy Storage (CAES) Project

300 MW, up to 10 hours storage*

3 phases:

1. Permitting, reservoir testing, transmission interconnection, plant design ($25 million DOE match funding awarded 12/31/09)
2. Bid and plant construction
3. Monitoring



Partners:

EPRI ELECTRIC POWER RESEARCH INSTITUTE

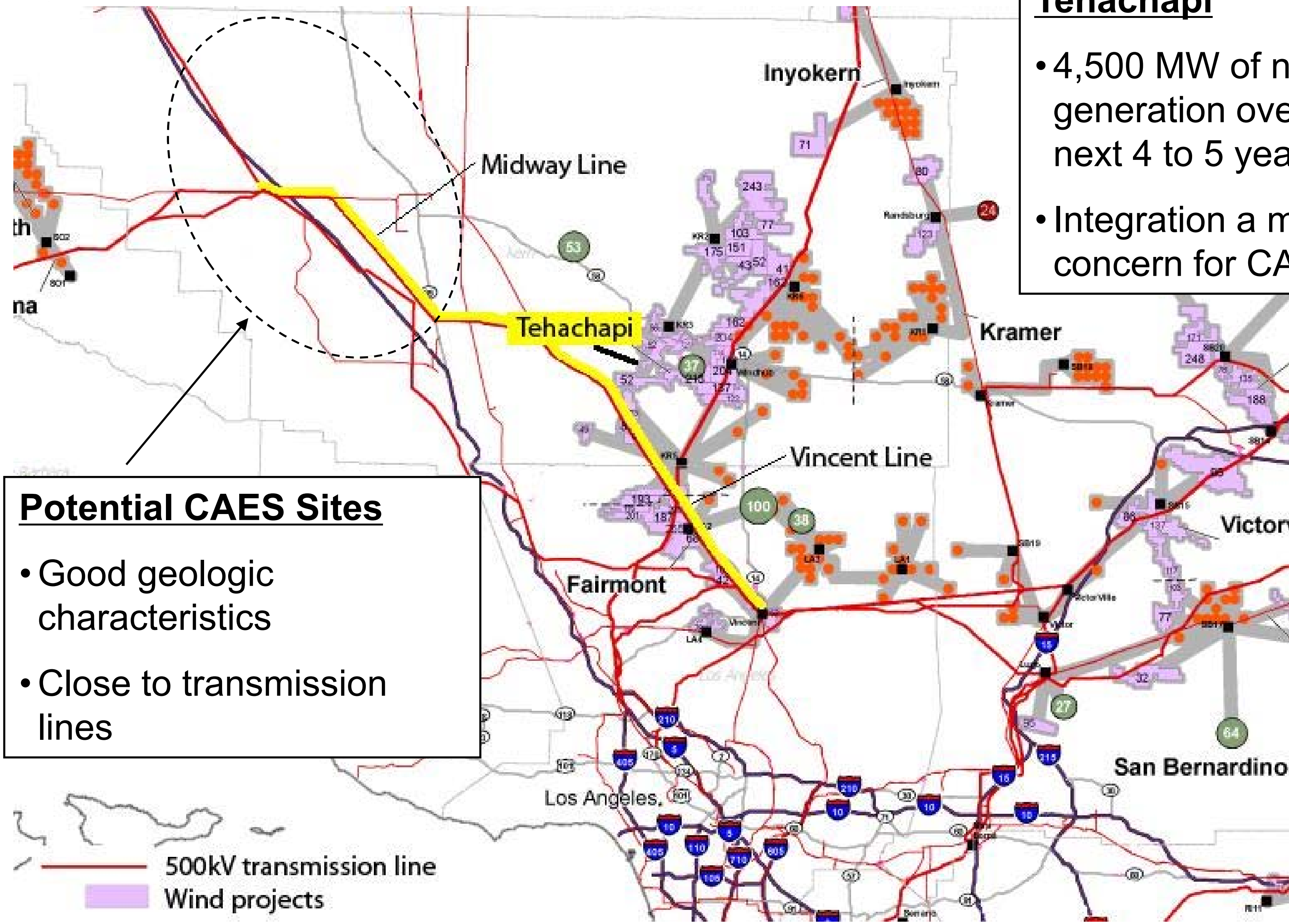
California ISO Your Link to Power

Funded by:

- Integrate intermittent renewables
- Store off-peak energy
- Provide ancillary services
- Manage peak demand
- Relieve grid congestion
- Use porous rock reservoir

* Final Project size will be determined by reservoir size and definition and by testing results, subject to management and CPUC approvals.

CAES Plant Site To Be Near Wind Resources



Tehachapi

- 4,500 MW of new wind generation over the next 4 to 5 years
- Integration a major concern for CAISO

Potential CAES Sites

- Good geologic characteristics
- Close to transmission lines

PG&E CAES Plant Has Attractive Operational Performance Characteristics

- Operates in both the charge and discharge modes simultaneously with a “flat” energy ratio & heat rate
  - **This enables the plant to obtain spinning reserve and ramp up/down benefits while at part load.**
- Plant is a flexible resource during the charge and discharge mode
  - **In particular, at part load operation the plant provides a combination of arbitrage, frequency regulation and ramping benefits**
- Ramp rate is about +/- 40% minute
  - **For example, a 300 MW Advanced CAES Plant that is synchronized to the grid, can change output power at +/- 120 MW’s per minute. This makes the plant effective at performing up-ramps and down-ramps as wind power fluctuates, and/or, as market price signals change.**

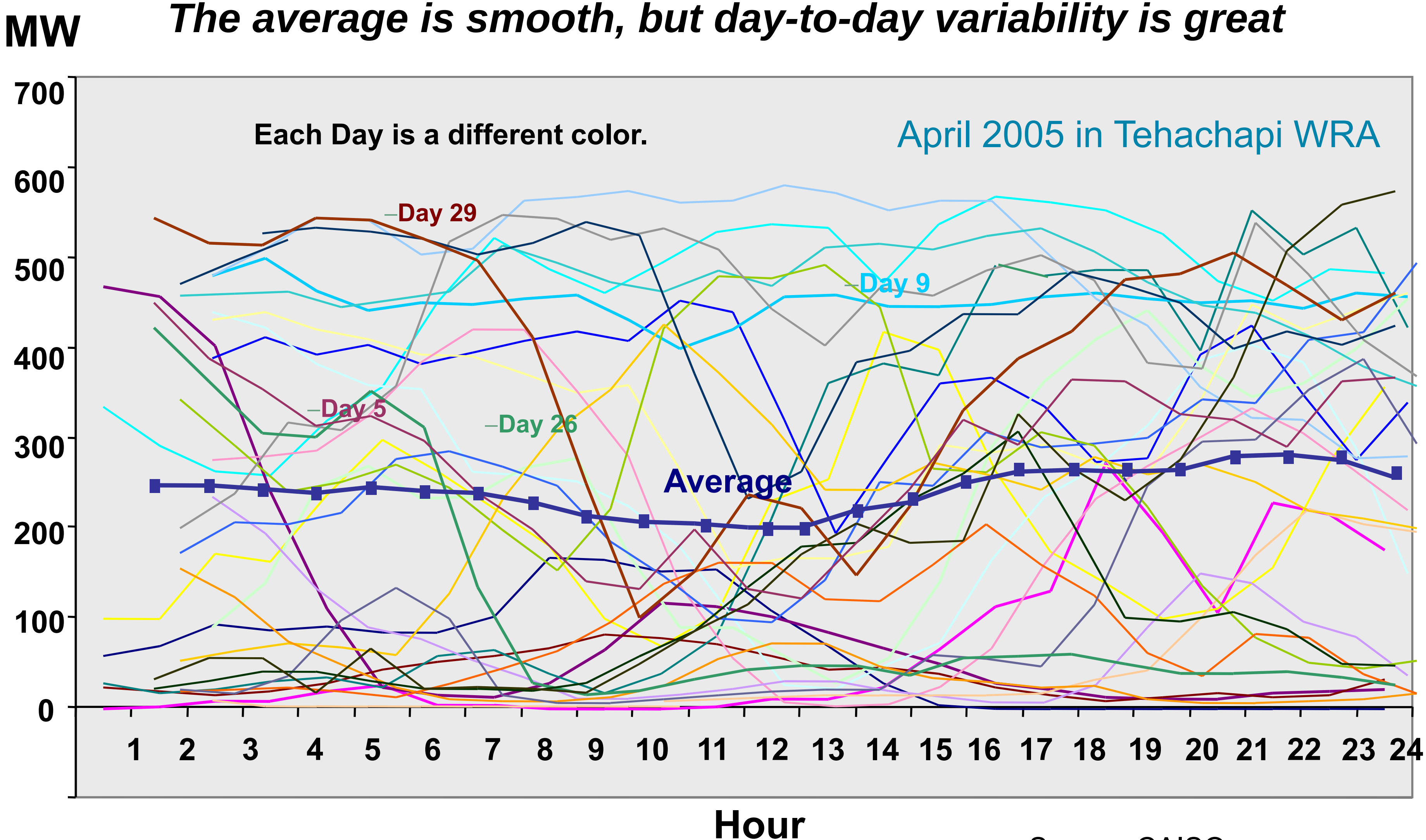
Summary

- PG&E NaS Battery Plant (4 MW – 7 Hours):
  - Commercially Available With Warrantees
  - Response Time: Seconds
  - Excellent Application To Mitigate Power Fluctuations From Solar Plants, Provide Frequency Regulation And To Control Real & Reactive Power To Key Industrial Customers
  - Planned Operational Date: 2011
- PG&E CAES Plant (300 MW – 10 Hrs.)
  - Lowest Cost Large Scale Energy Storage Plant
  - Response Time: Minutes
  - Excellent Application To Control Large Power Fluctuations From The Increasing Amount Of Wind and Solar Plants
  - Planned Operational Date: 2017

Questions ?

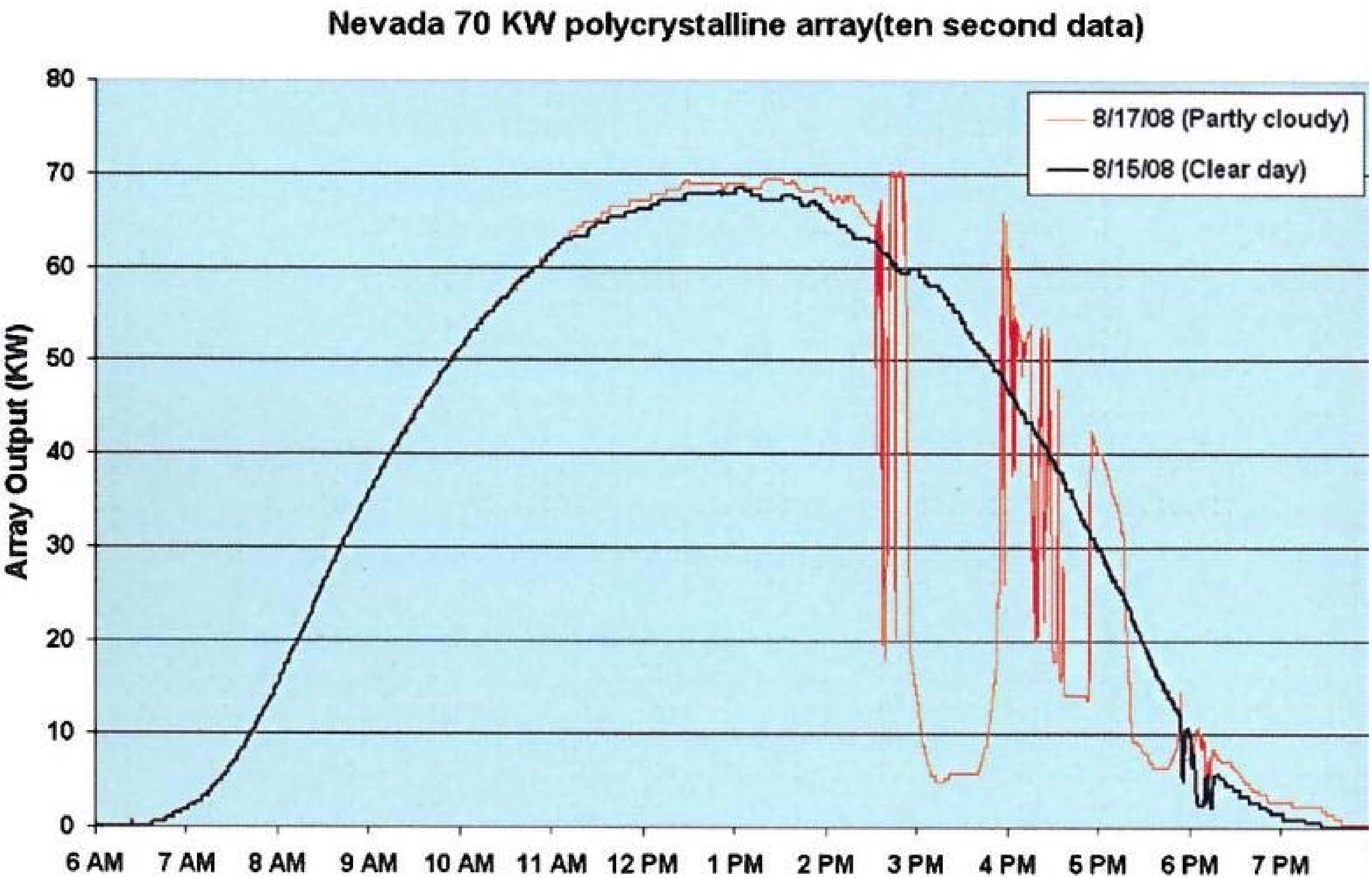
Wind Generation Varies Widely

The average is smooth, but day-to-day variability is great



Source: CAISO

Large Variation of Solar PV System Output

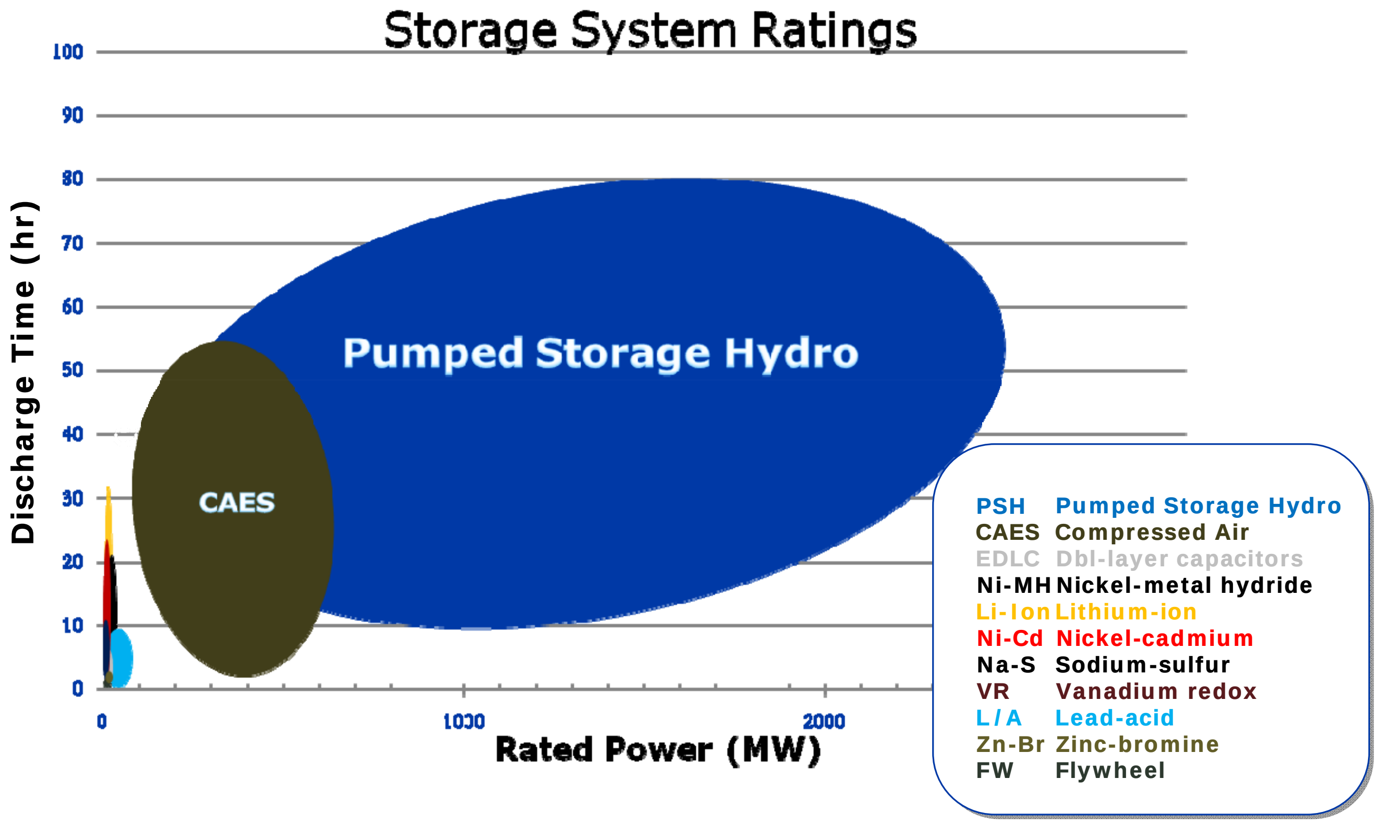


Source: AES

Why CAES?
- It Meets Utility-Scale Needs

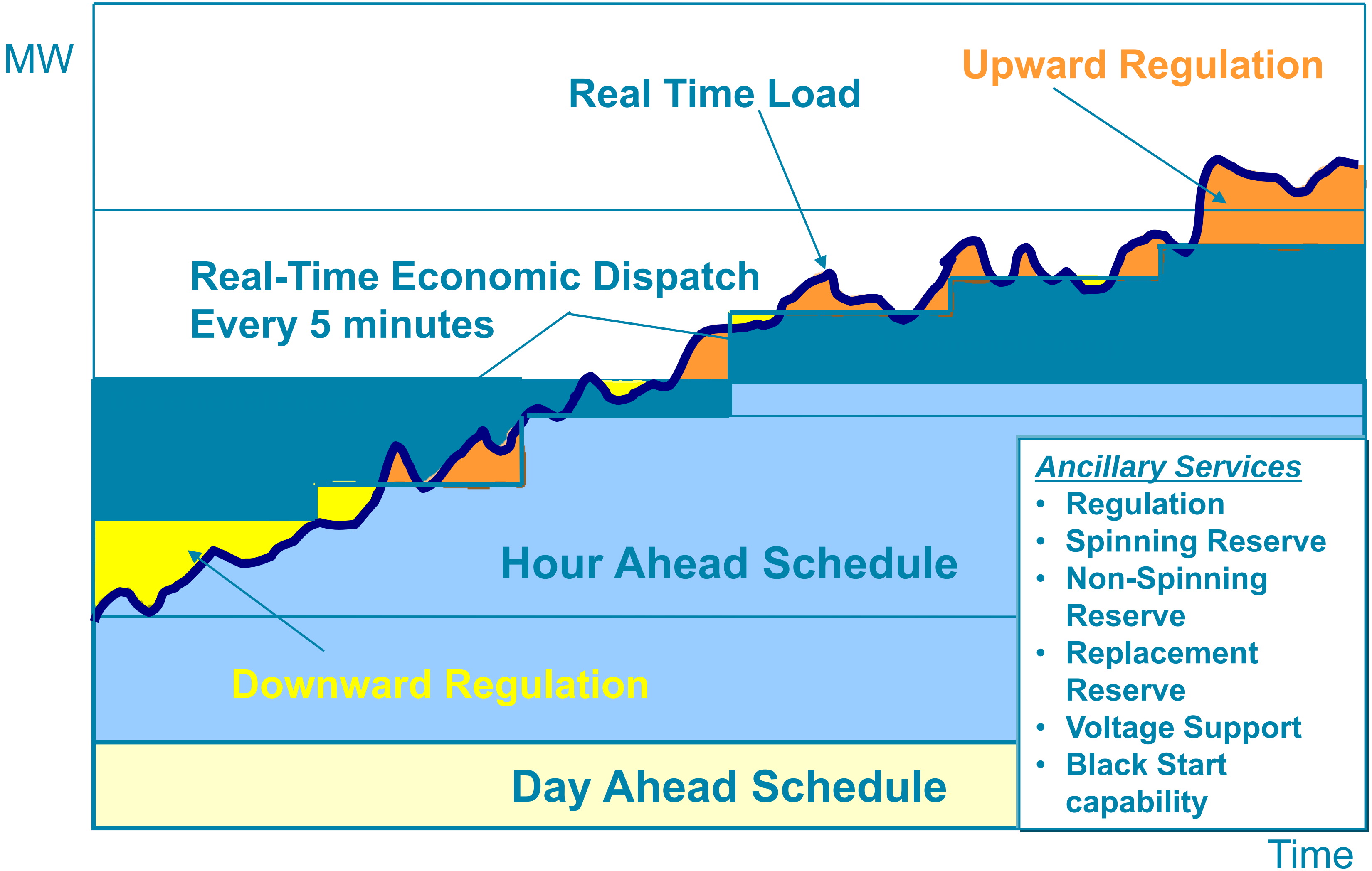
Appendix

Energy Storage Technologies



Source: Same as prior graph by Electricity Storage Association (converted to normal scale by Rick Miller, HDR | DTA)

Balancing Function - Area Control



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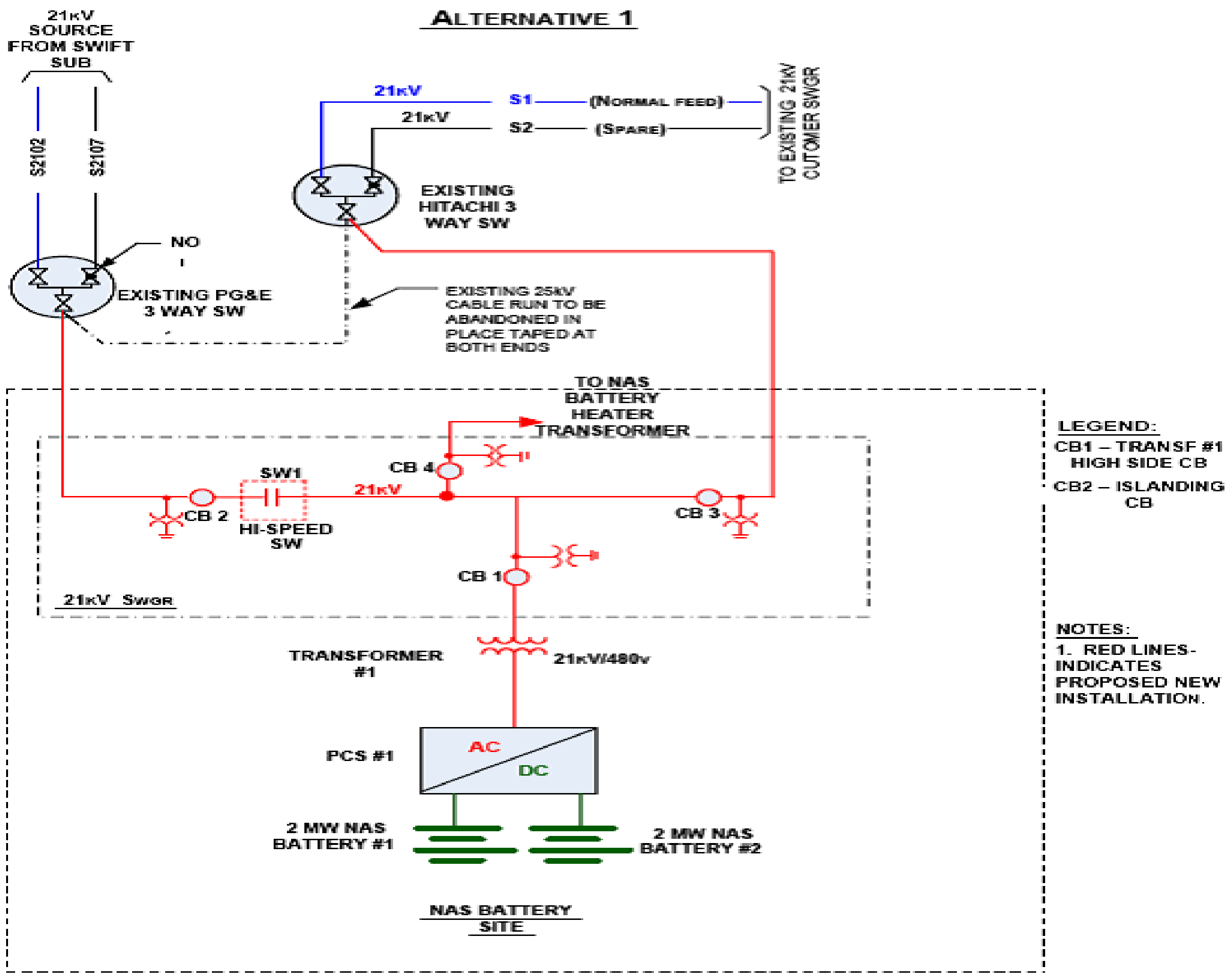
PG&E NaS Battery Plant: Single Line Diagram (Draft)

Appendix



Hitachi Substation Schematic

PNNL-SA-76347

How to integrate energy storage and demand response into the wide-area network control of the electric grid: Two specific technology examples

Jeff Dagle, PE
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Pacific Northwest National Laboratory
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California Energy Commission Staff Workshop on Technologies to Support Renewable Integration (Energy Storage and Automated Demand Response)

November 16, 2010

Pacific Northwest NATIONAL LABORATORY

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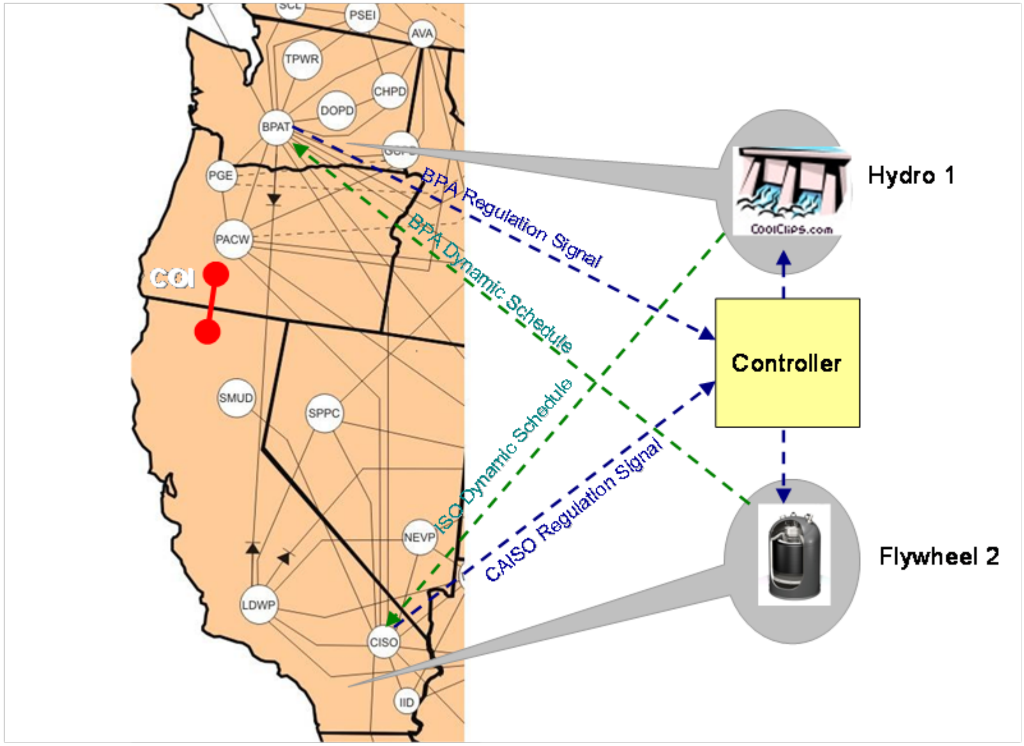
Example #1: Wide-Area Energy Management Storage (WAEMS) Concept

A wide-area energy storage concept is proposed that provides a centralized control system that operates energy storage devices located in different places to provide energy and ancillary services that can be shared among balancing authorities.



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Modeled Benefits of the WAEMS Concept

- Reduce regulation reserve by up to 30%
- Provide fast, cost-effective, and efficient ancillary services
  - Minimize wear-and-tear of conventional regulating units
  - Operate conventional regulating units close to their most efficient operating point
  - Allow the storage devices to excel in specific applications that fit their characteristics
    - Allow flywheel to follow fast regulation signals and hydroelectric to support the flywheel by maintaining a reasonable state-of-charge
- Easy scalable technology
- Compatibility:
  - Fully compatible with the existing BPA and CAISO AGC systems
  - Fully compatible with the other technologies such as ACE Diversity Interchange (ADI)
- Can be used with the other Balancing Authorities

Flywheel Field Tests

- **Objective**: To validate the ability of flywheels to meet the performance demands of the wide area energy management concept to support renewables integration
- Evaluated a 25-kWh, 100-kW flywheel

Field Test Design

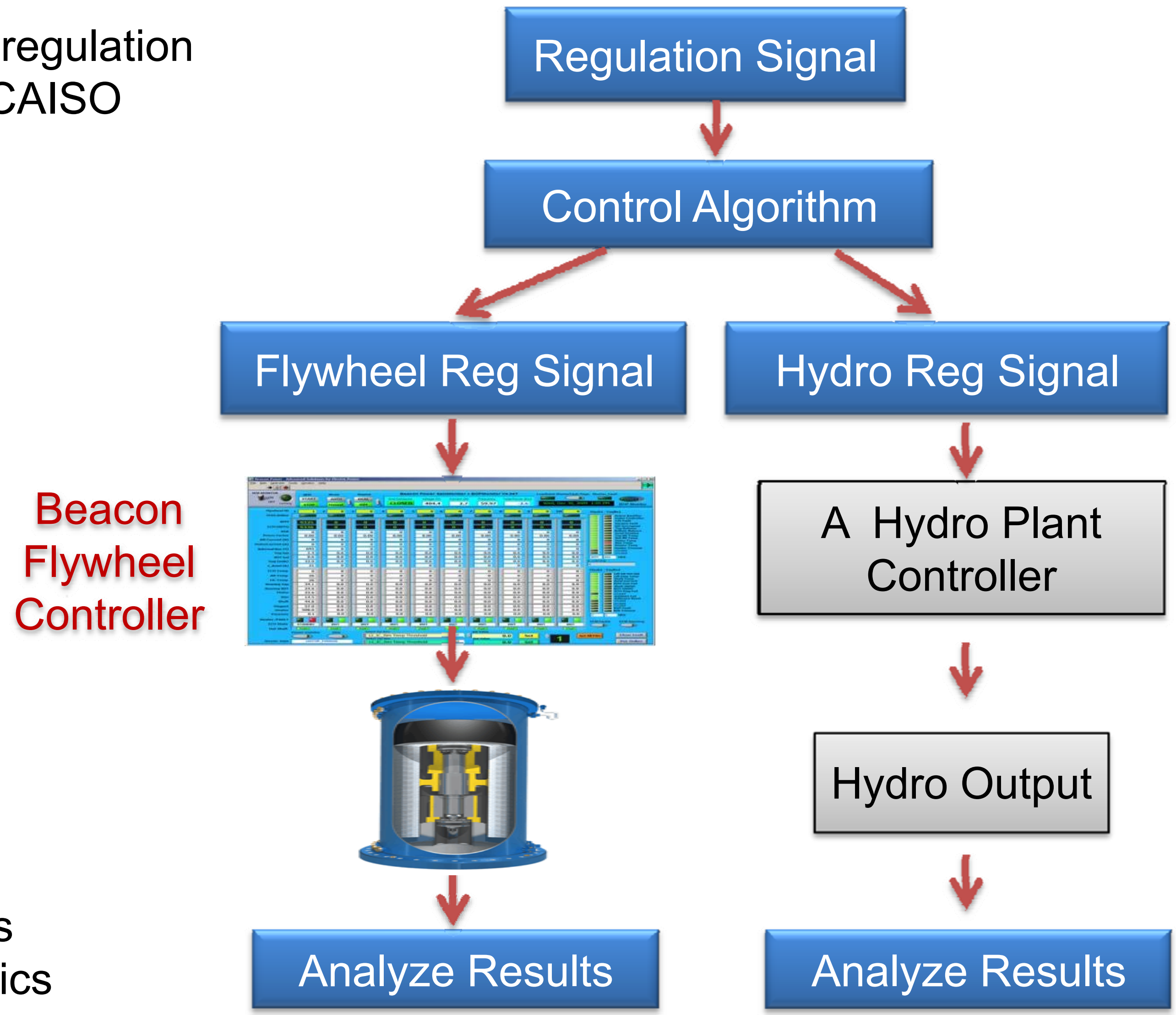
2009 April ACE and regulation data from BPA and CAISO

Implemented on Beacon Flywheel Controller

Field tests conducted at the Beacon Power facility

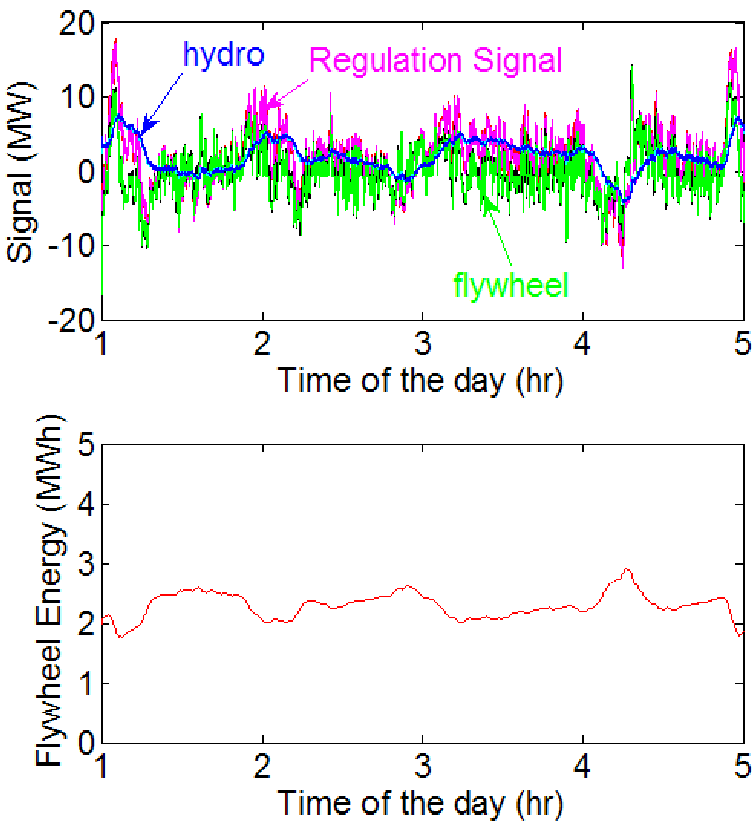
Evaluation:

- Economic Analysis
- Performance Metrics

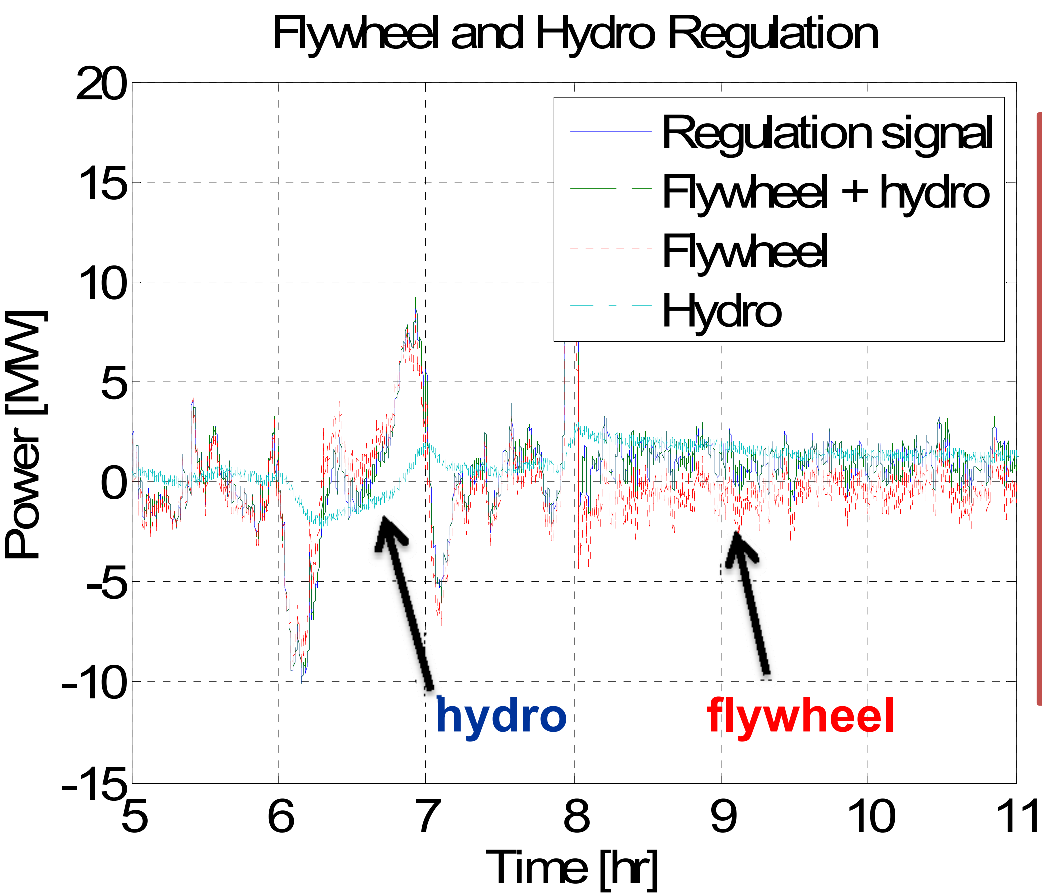


The Flywheel Field Test Results

- The flywheel followed regulation signal with minimal response delay
- The WAEMS algorithm successfully allocated the fast regulating signal to the flywheel and the slow one to the hydro
- The flywheel state-of-charge was maintained within its capacity limit by the support from the hydro unit



An Example Result:
Flywheels+ Hydro plants



Calculated Breakeven Prices:
Pay-by-capacity
Flywheel-hydro: $12.19/ MW
Flywheel alone: $20.37/ MW

CAISO:
$11.95/ MW for regulation
BPA:
$9.38/ MW for regulation

If the same service was provided by the flywheel alone, because the regulation signal is biased, the flywheel will be out of energy in some hours and will not comply with the regulation requirement. This might double or triple the cost for the flywheel to provide the regulation service.

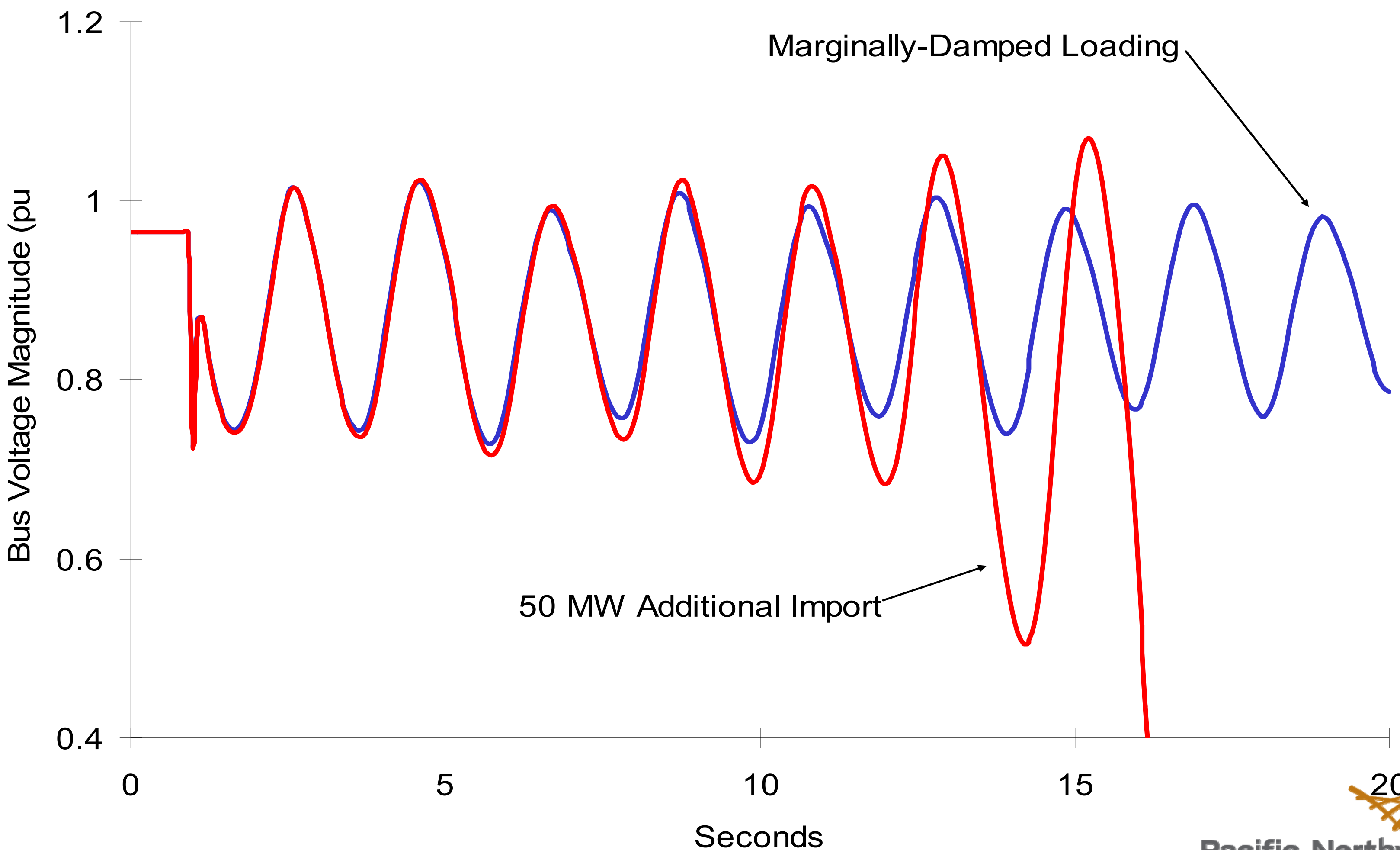
Conclusions – Flywheel Field Test

- Flywheel response delays are within seconds and state-of-charge is well maintained
- The WAEMS control algorithm successfully allocated the fast regulating signal to the flywheel and the slow one to the hydro
- The WAEMS combined service has
  - Fast response characteristic
  - No strict energy storage limitation
  - Better performance and more economical than flywheel-only service
- MW regulation service provided by a MW flywheel and MW hydro (assuming its cost is $4 /MW) system will then cost $12.19 /MW as compared to the average CAISO ($11.95/ MW) and BPA ($9.38/ MW) regulation price
- The WAEMS controller helped the hydro unit to reduce the wear and tear and allow it to operate close to the most preferred operating point

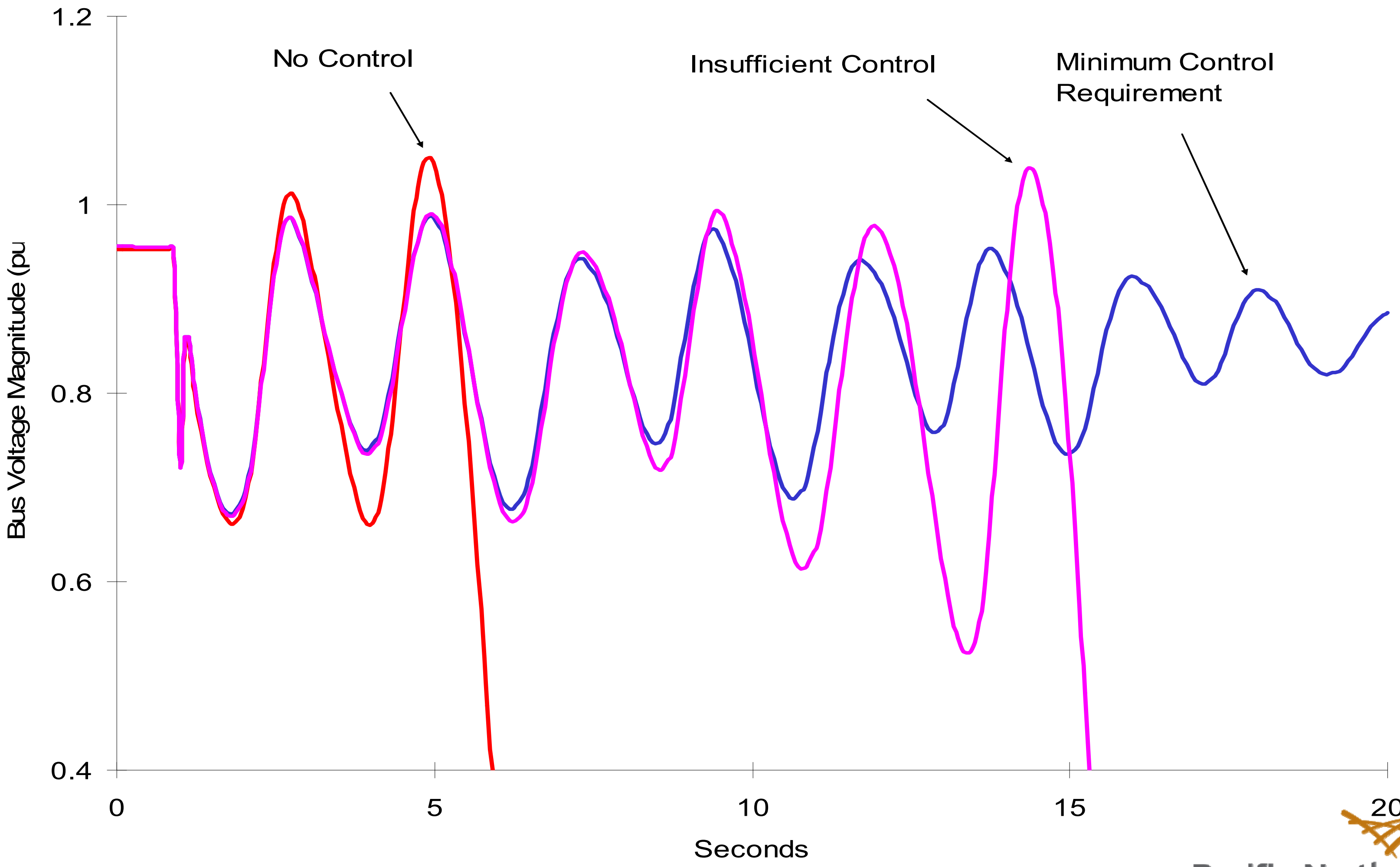
Example #2: Dynamic Load Control to Stabilize the Transmission Network

- Internally-funded research project in fiscal year 1996
- EPRI's Power System Analysis Package
  - Extended Transients / Mid-Term Stability Program (ETMSP)
  - Small Signal Stability Program (SSSP)
- WECC model (5000 bus)
  - 1999 heavy summer case
- Objective: Increase 'east of river' flow for stability-constrained import into Southern California
  - SCIT Nomogram
- Determine: Minimum control action for a given regional power import increase
  - dispersed control points
  - feedback modulation (compensation)
  - real- and/or reactive-power injection

Marginally-Damped Loading



Imports Increased 400 MW



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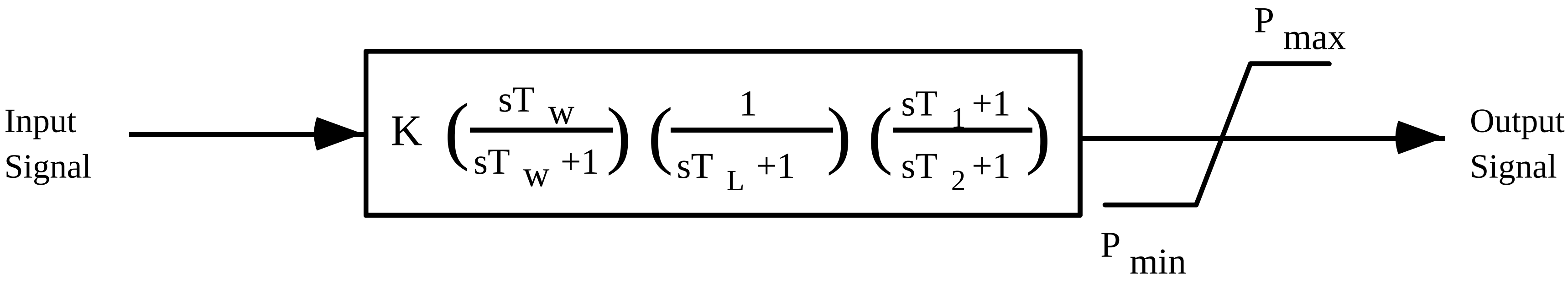
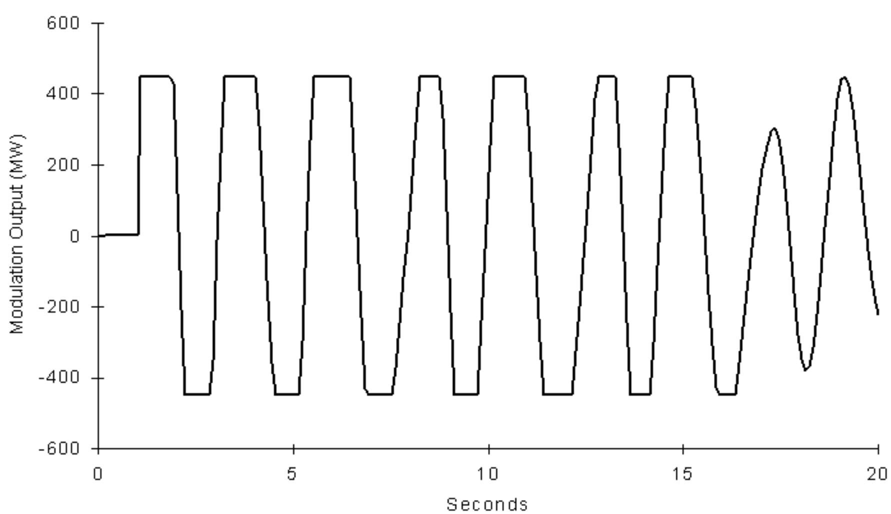
Modulation Control Block Diagram



Typical Modulation Output



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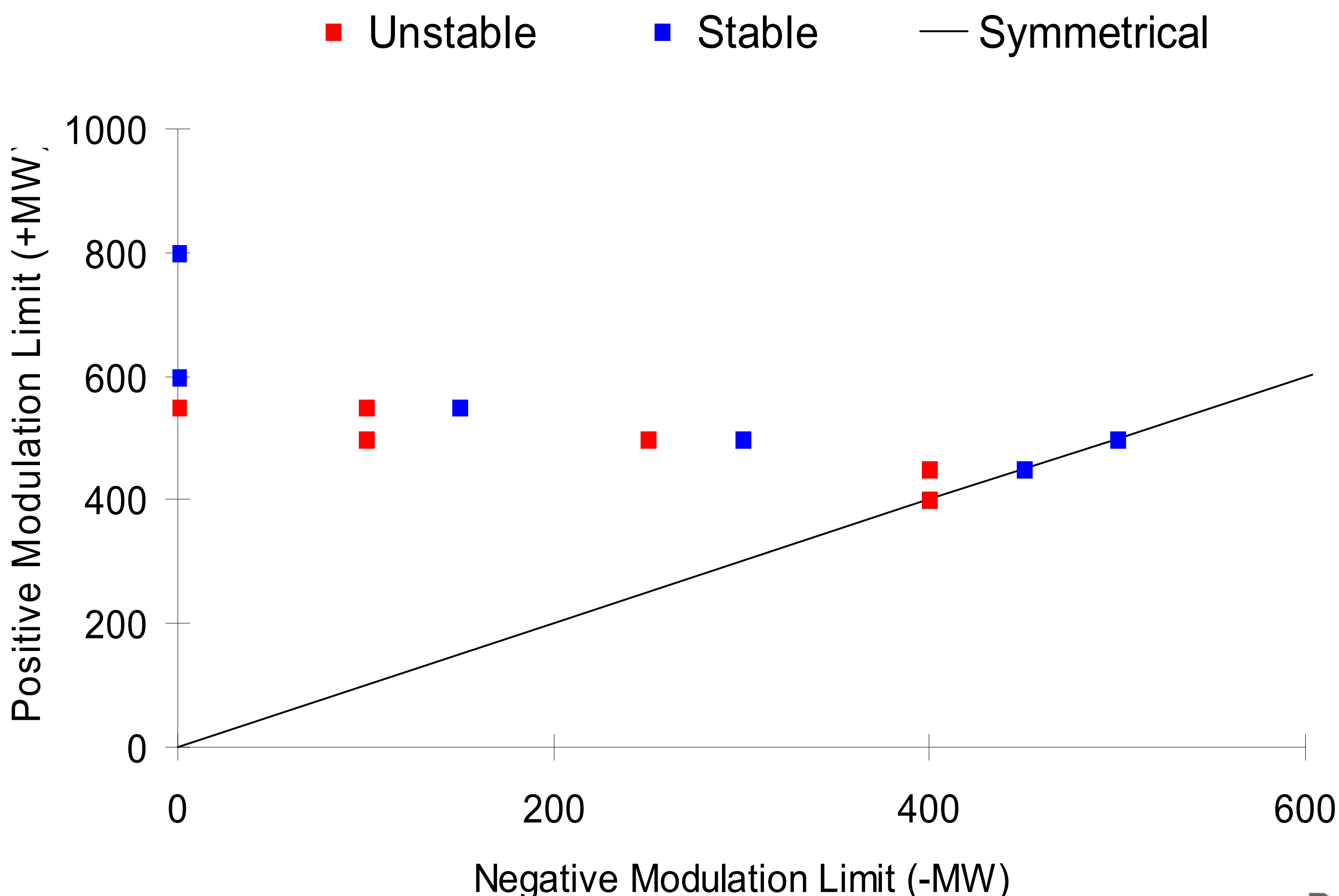
Simulation Results – Single Location

- Minimum modulation required at a single location necessary to provide 400-MW transmission enhancement
  - Real power modulation ± 450 MW
  - Reactive power modulation ± 500 MVAR

Asymmetrical Modulation



Study Results

- Dispersed control leverage
  - 1 actuator = 600 MW
  - 10 actuators = 44 MW ea. (440 MW total)
  - similar results with 100 actuators
- Modulation input signals
  - local voltage or frequency yielded similar results to a common input signal
  - frequency has inherent advantages (universality)
- Issue remains: How to implement?

From then to now…

- Early conceptual framework for the *GridWise*™ initiative
  - Research now supported by the U.S. Department of Energy Office of Electricity Delivery and Energy Reliability
  - Grid Friendly Appliance (GFA) technology being developed
  - GFA technology currently being field tested in conjunction with the Pacific Northwest GridWise™ Testbed Demonstration
    - Olympic Peninsula Demonstration
      - Demand reduction in response to market signals, part of Bonneville Power Administration's non-wires initiative
    - Grid Friendly Appliance Demonstration
      - Automatic underfrequency load shedding of certain interruptible appliances
- Additional research, development, and demonstration would be needed before this concept is ready for deployment to address grid operational issues

SMUD's Energy Storage and Open ADR Activities

CEC Staff Workshop on Energy Storage and Automated Demand Response Technologies to Support Renewable Energy Integration

November 16, 2010

Jim Parks

Program Manager

SMUD

SACRAMENTO MUNICIPAL UTILITY DISTRICT

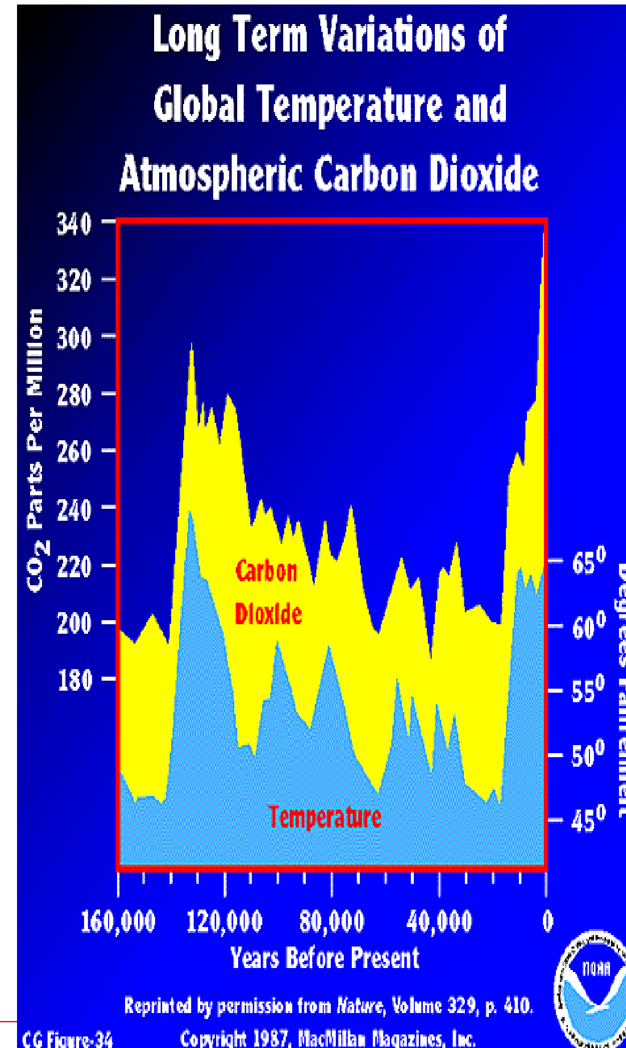
The Power To Do More.℠

What Is Driving SMUD's Renewables & Storage Interest?

- GHG regulations
  - Reshaping energy supply
  - Prompting PHEV development
- RPS and wind and solar energy additions
  - Transmission development issues
  - Wind — weak forecasting, large ramps, unpredictable production during super peaks
  - Solar — peaks 4-5 hours before utility peak
- Summer peak load
  - 400 MW problem for 40 hours

Sustainable Energy Supply Policy

- Reduces SMUD's long-term *greenhouse gas emissions to 10% of its 1990 carbon dioxide emission levels by 2050* (<350,000 metric tonnes/ year), while *assuring reliability of the system; minimizing environmental impacts*; and *maintaining a competitive position* relative to other California electricity providers.



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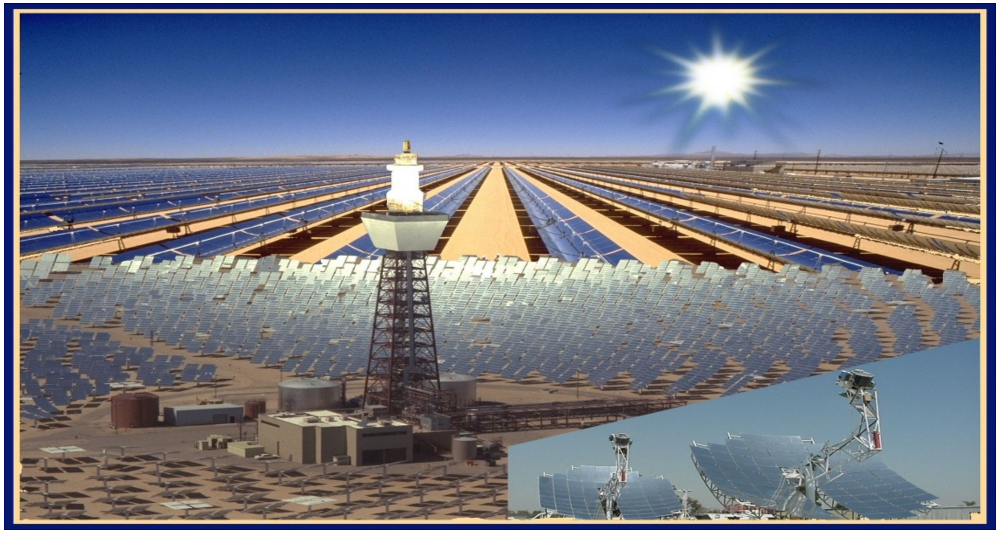
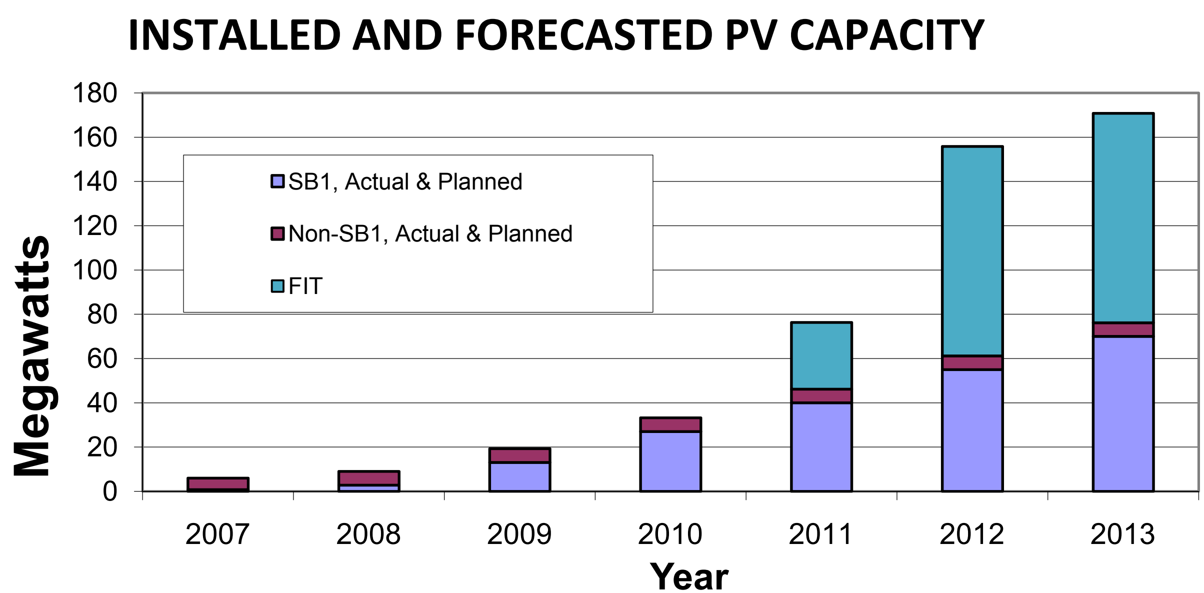
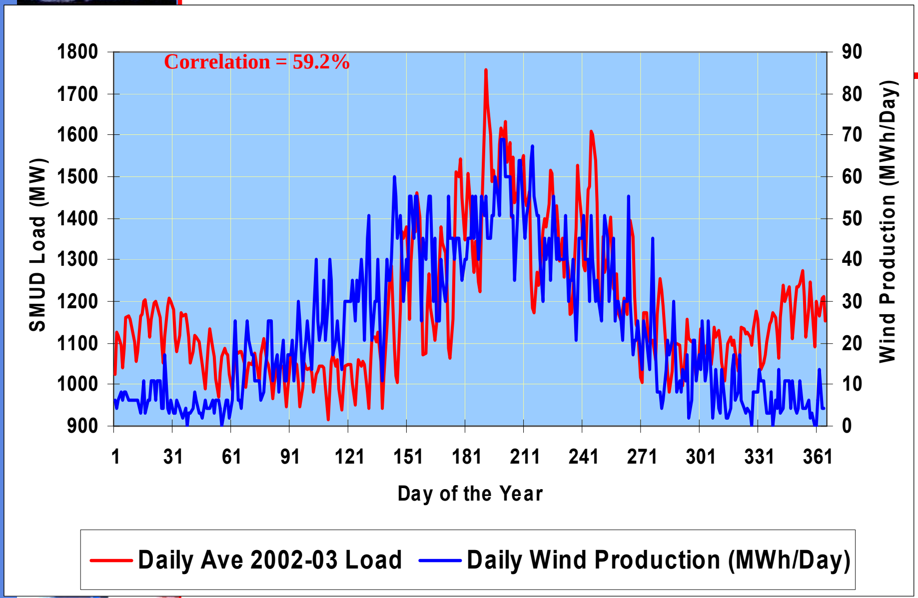
The Power To Do More.℠

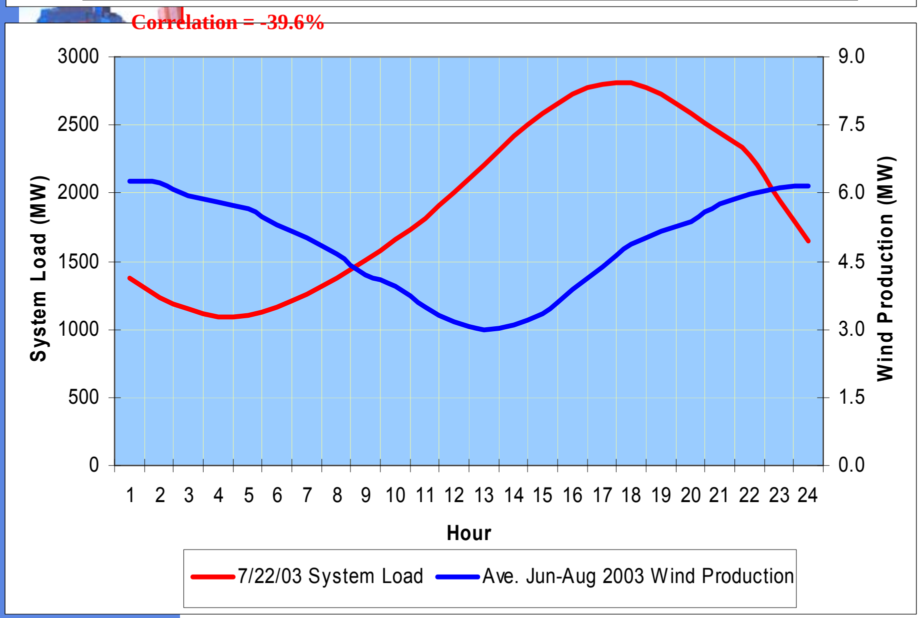
Solar Energy's Growing Role





Wind Issues For SMUD





- SMUD's peak load driven by hot summer temperatures
- Wind resource weakest on hottest days
- Comparing daily and hourly system load with Solano Wind Plant production illustrates mismatch
- Must rely on firming resources to address mismatch and ensure system stability

SMUD's Storage Approach

- SMUD is evaluating bulk and distributed storage
- Questions of what kind, how much of it and when, how to quantify value, and how much cost
- Pursuing a multi-pronged approach
    1. Developing improved understanding of storage technologies
    2. Determining benefits of distributed storage to SMUD
    3. Conducting some demonstrations, monitoring performance and cost effectiveness
    4. Preparing SMUD for energy storage utilization
- Conducting Studies on Bulk (CAES, Pumped Storage) and Distributed Storage (Li-Ion & Flow Batteries)

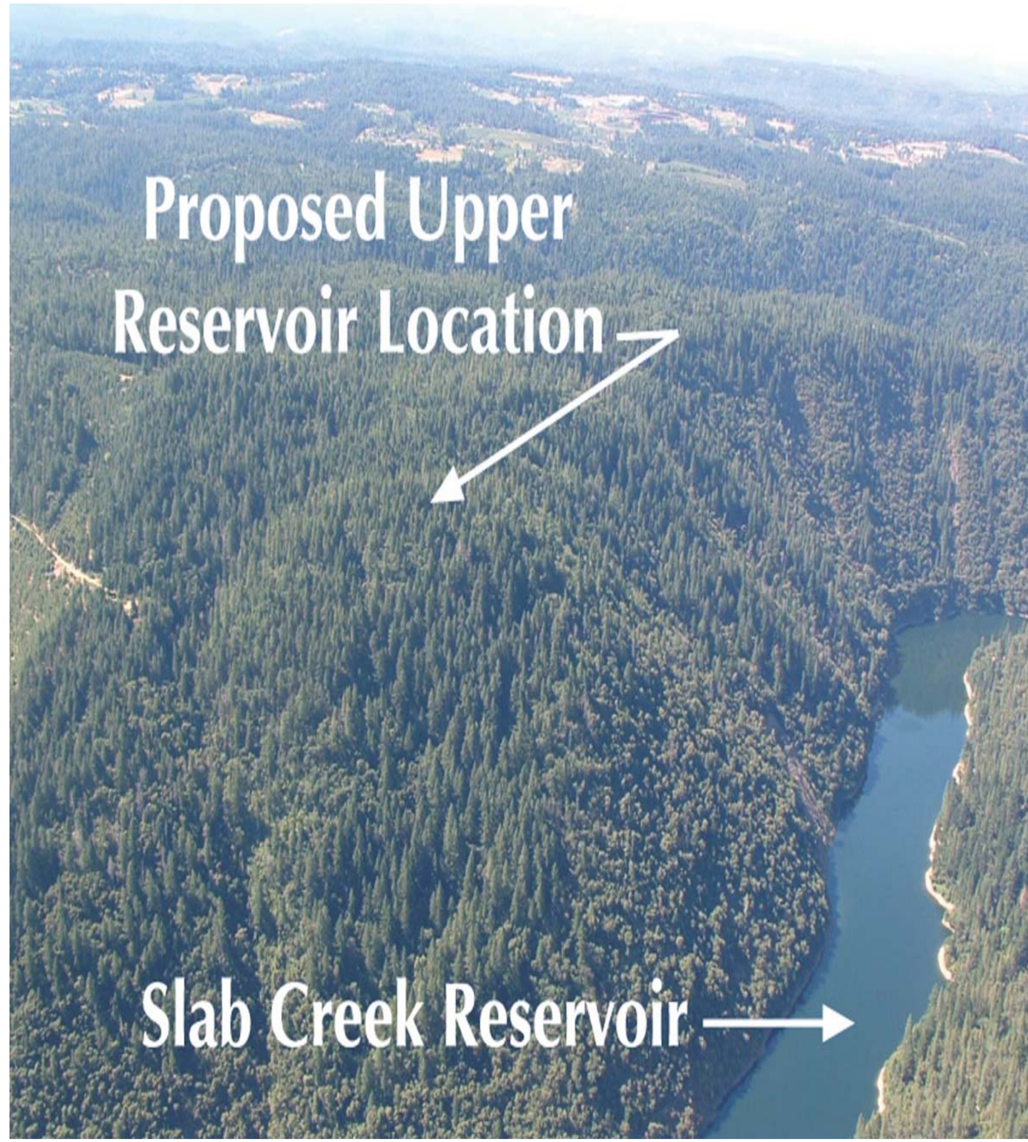
SMUD's Proposed Pumped Hydro Project

Key Features of Iowa Hill

- New development added to existing hydro system
- 400-MW Pumped-storage facility
- New 6,400 ac-ft reservoir atop Iowa Hill
- Existing Slab Creek Reservoir as lower reservoir
- Underground water conveyance and powerhouse
- 2.5-mile transmission tie-in connects to existing UARP transmission line

Benefits

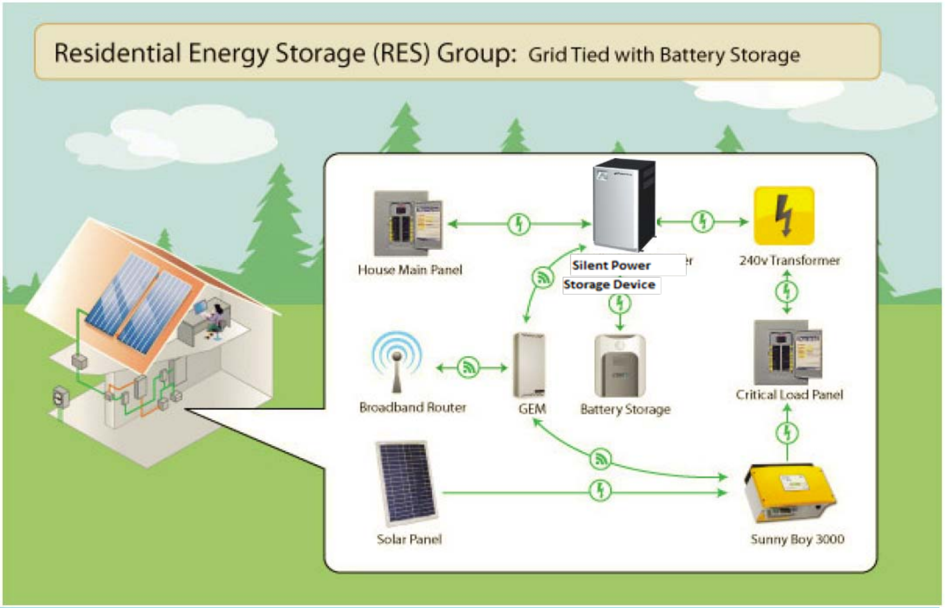
- Helps meet load growth
- Enables firming capacity of intermittent, non-dispatchable renewables
- Supports load following, improves system reliability, provides voltage control and spinning reserves

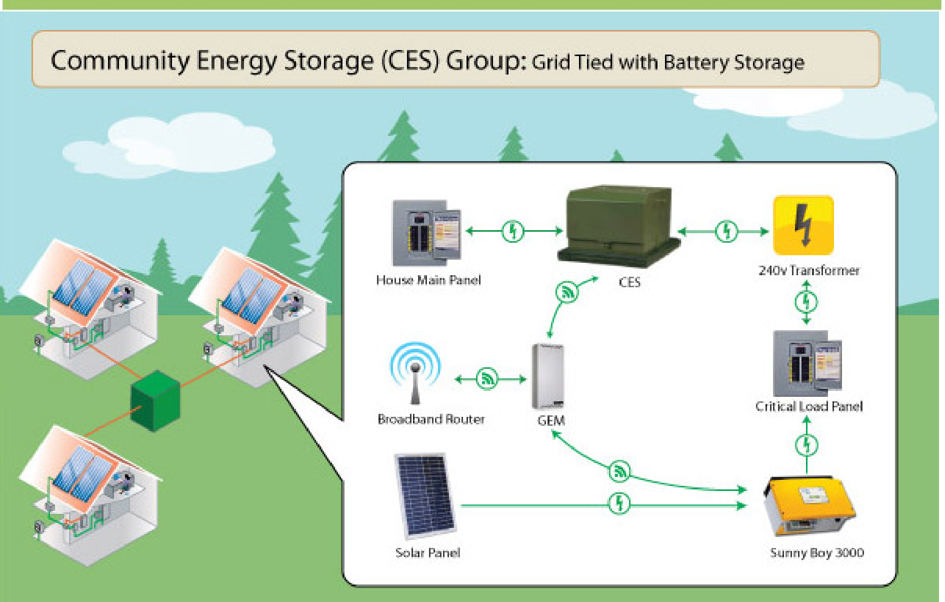



Tree Clear Radius: 500ft
Height Above Ground: 652.6ft

SMUD PV & Smart Grid Pilot at Anatolia

ARRA FOA 85 Topic 4: High Penetration Solar Development



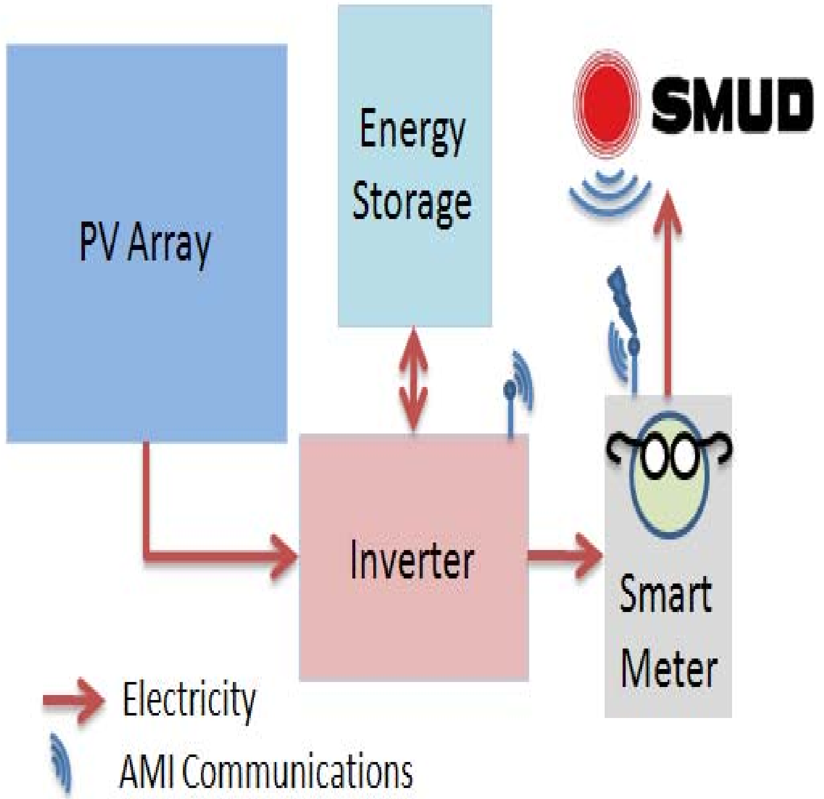


- Partners include CEC, GridPoint, SunPower, Navigant, NREL
- Will firm renewables, reduce peak load and improve reliability
- Installing 15 RES and 3 CES units in Anatolia SolarSmart^{SM} Homes that currently have 2kW PV systems
- Installing utility and customer portals to monitor PV, storage, customer load
- Sending price signals to affect changes in customer usage
- Developing specification for smart meter/inverter interface to enable management of distributed PV/storage system with AMI
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

SMUD PV & Smart Grid Pilot at Anatolia (Cont'd)

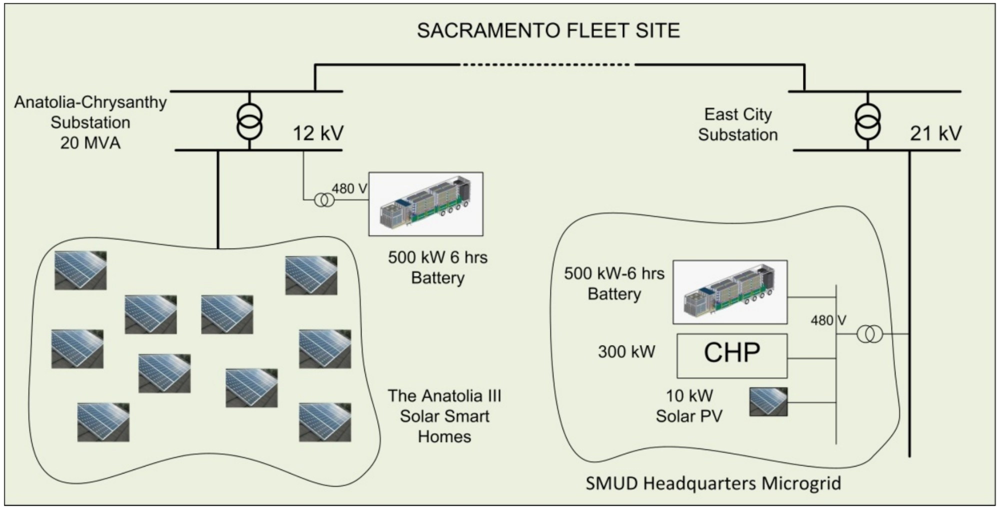
Inverter Communications

- Demonstrate Inverter Monitoring via AMI communication from smart meter to inverter
- Demonstrate receiving data, querying for faults, sending control signals
- Utilized as actively controlled contributors versus passive devices on the grid



Storage for Grid Support

ARRA FOA 36 Topic 2.3: Regional Smart Grid Demos



Benefit	Metric	Sacramento Fleet
Peak load reduction	Peak Load	5-10%
T&D loss reduction	T&D Losses	2%
Reduced cost of power interruption	CAIDI/SAIDI/SAIFI improvements	10%
Reduced damages as a result of lower GHG/carbon emissions	MWh served by renewable sources	TBD
Reduced cost to serve peak energy (energy arbitrage)	Hourly marginal cost data	70%

- Partners include CEC, Premium Power, National Grid, SAIC, NREL, Syracuse University
- Will firm renewables, reduce peak load and cost to serve peak, and improve reliability
- Installing two 500kW – 6 hours systems
- Operating as a fleet of distribution assets
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

Current/Future Projects with CEC

1. **Plug in electric vehicle grid impact study**
   - Study the effects of electric vehicle charging cycles on residential distribution transformers – 25 kVA, 50 kVA and 75 kVA
   - Develop battery pack to simulate 1-5 electric vehicles and plug into loaded transformers to test impacts
2. **Battery/PV optimization**
   - Install ~150 kW flow battery at electric vehicle charging facility (20 – level 2 and 1 – level 3) with 80 kW of PV to test grid optimization through the battery

Open ADR (Auto DR)

- SMUD has $1.5 million in the ARRA SGIG contract for auto DR
- Auto DR will be incorporated in partner locations first (LRCCD, CSUS, DGS)
- RFP process to hire consultant/implementation contractor
- Results from partner projects will roll into customer program






Summary

- Storage and demand response will play a significant role in SMUD's future
  - SMUD GHG goals & RPS driving SMUD to more renewables, creating a need for more storage and demand response
  - Transmission constraints driving SMUD to local solutions
  - Looking to Smart Grid technologies to help optimize grid operations, intermittent resources, distributed generation, two-way power flow, etc.
  - Storage could be a viable mitigation solution that provides multiple benefits

Automated Demand Response: a Grid Resource for Integration of Renewables

IEPR Meeting

November 16, 2010

Lawrence Berkeley National Laboratory

Demand Response Research Center

Sponsored by California Energy Commission, US Dept of Energy

mapiette@lbl.gov

http://drrc.lbl.gov/

Overview

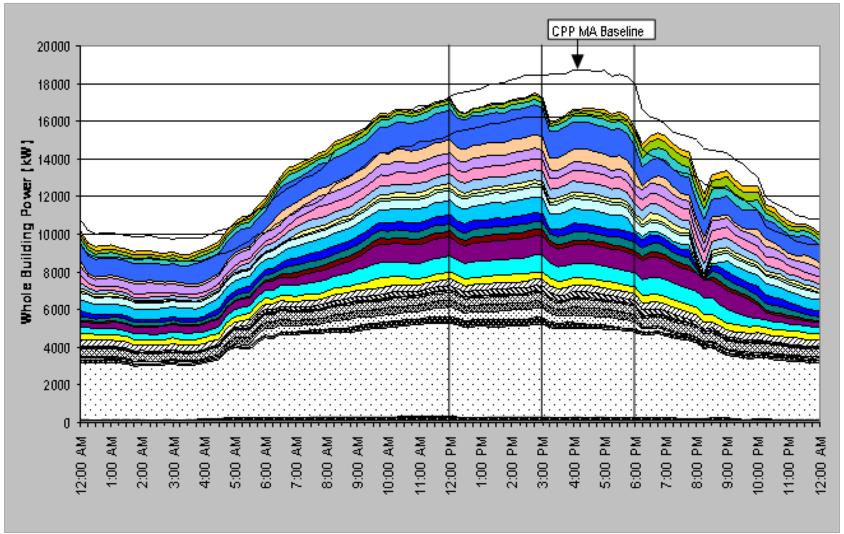
1. Background and Goals
2. Traditional Ancillary Services & Automated DR
3. Automated DR: Proven Results & Future Challenges
4. Methodology
5. CAISO Programs
6. Preliminary AutoDR Resource Estimate
7. Future Research

Background & Goals

Background

- California Renewable Portfolio Standards increasing to 33% by 2020
- Wind & Solar resources are variable and intermittent
- Grid requires over 4 GW of ancillary service to maintain grid stability
- Automated Demand Response pilots demonstrated ancillary services

Goal of Scoping Study – Develop preliminary estimate and feasibility of capacity of AutoDR in California as a resource for renewables integration.



Traditional Ancillary Services & AutoDR

1. Traditional A/S methods:

- **Thermal generation plants use fossil fuels, & high cost.**
- **Grid-scale storage is environmental friendly, but cost is high ($1500 - $4000 / kW)**

2. Potential Advantages of AutoDR systems:

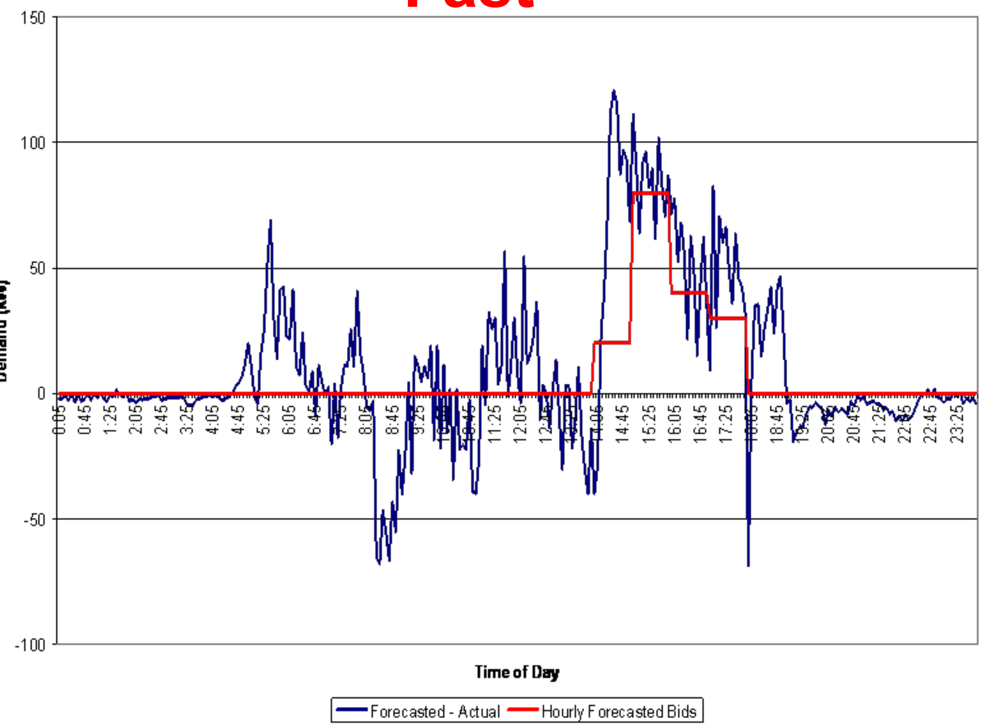
- **Lower first cost ($75 - $300 / kW) for current programs**
- **Lower operating costs**
- **Lower carbon footprint**
- **Leverages multi-purpose systems for energy efficiency**

AutoDR: Proven Results

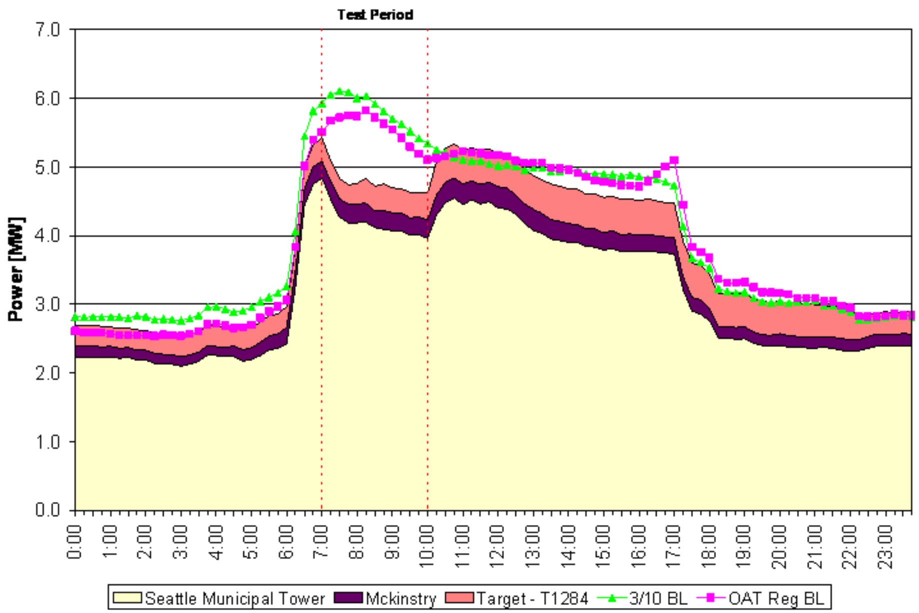
AutoDR Research & Commercialized Deployments have proven:

- **Multi-year performance during Peak Periods (~100 MW existing capacity)**
- **Fast response: < 5 min. (Participating Load Pilot)**
- **Cold winter mornings: 7:00 AM – 10 AM (Pacific Northwest Pilots)**

Fast



Early & Cold



Challenges for AutoDR as Ancillary Services

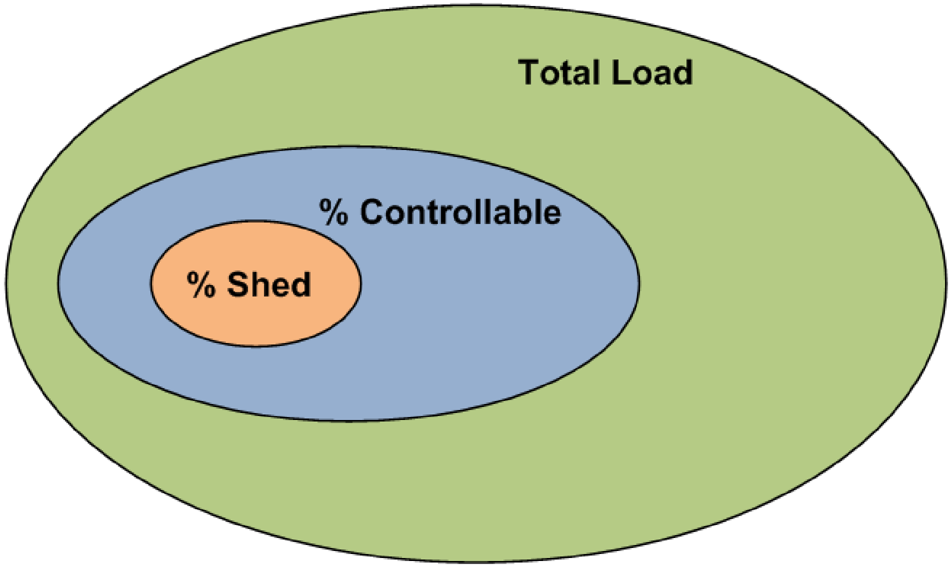
1. **Economic incentive structure unclear**
2. **Resource varies based on time, temperature**
   - Few data about off-peak DR
3. **AS requirements may increase cost of AutoDR**
   - Monitoring, verification, telemetry
   - Dedicated network connections
4. **Portfolio management**
   - Load shaping
   - Geographic issues (Sub-LAP)

Methodology for Resource Analysis

1. Determine total electric load profiles for commercial and industrial sectors & key end-uses

1. Determine % of loads that could be controlled using current site infrastructure, and AutoDR technology

1. Determine % shed for each controllable load



Estimated Shed = (Load) x (%Controllable) x (%Shed)

Methodology Assumptions

1. Statewide load data, field test results & engineering judgment used to estimate potential

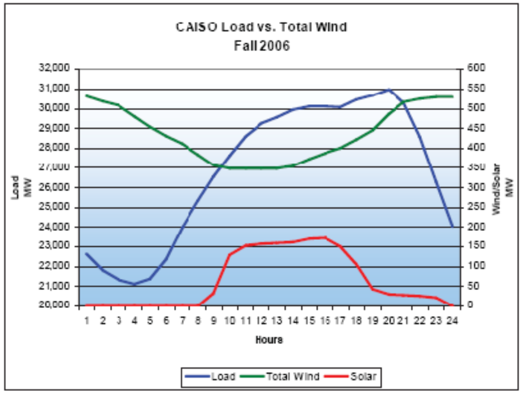
2. Multipliers selected based on existing or planned CAISO products for renewables integration

Duration	Ramp time
2 hour	15 min.
20 min.	5 min.

1. Commercial building type and end-uses evaluated

2. Industrial load shapes evaluated based on case studies and scoping studies

CAISO Programs and AutoDR

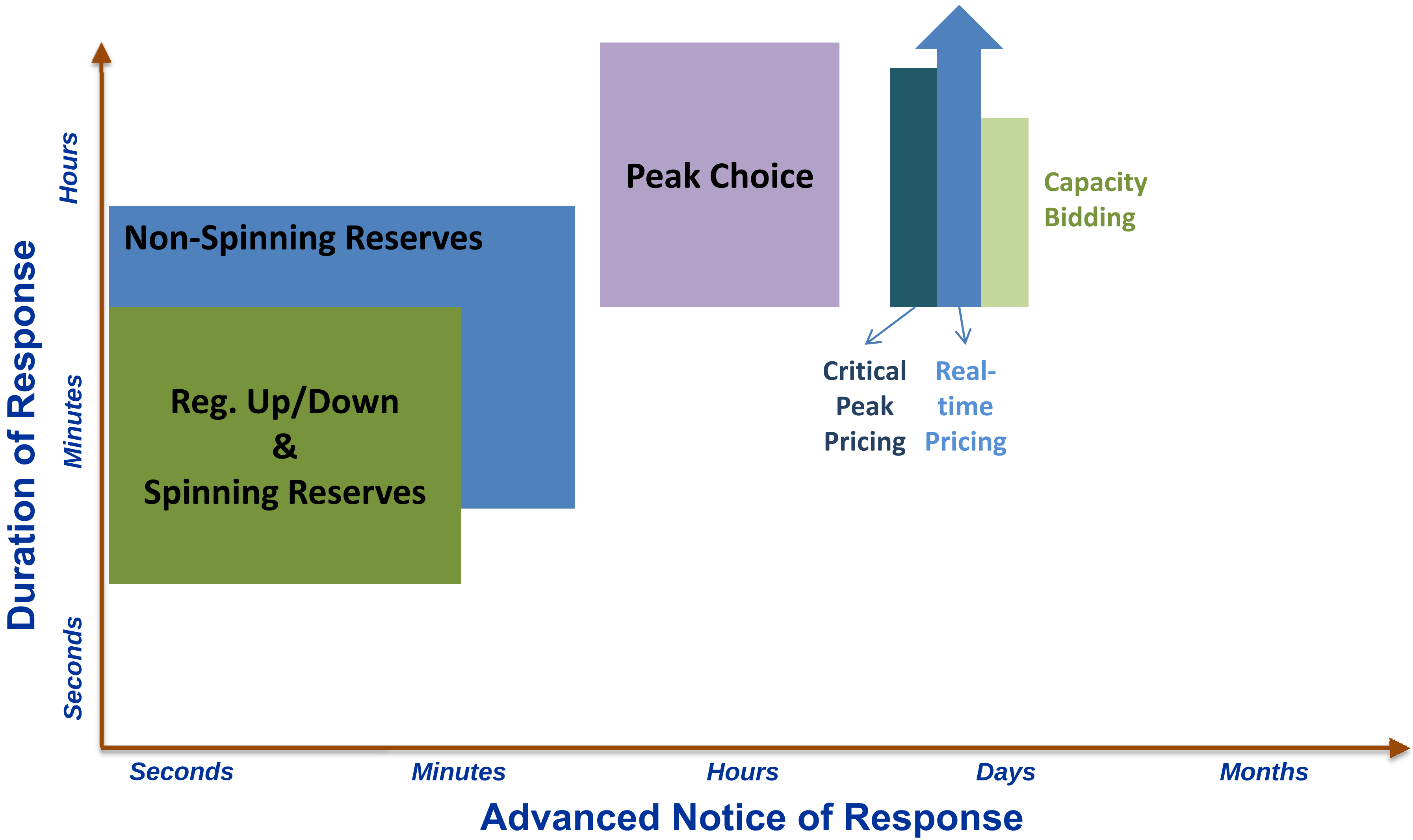


Examples of Needs for AutoDR

- Shift Load to Night
- Daily Peak Management
- Ramp Smoothing

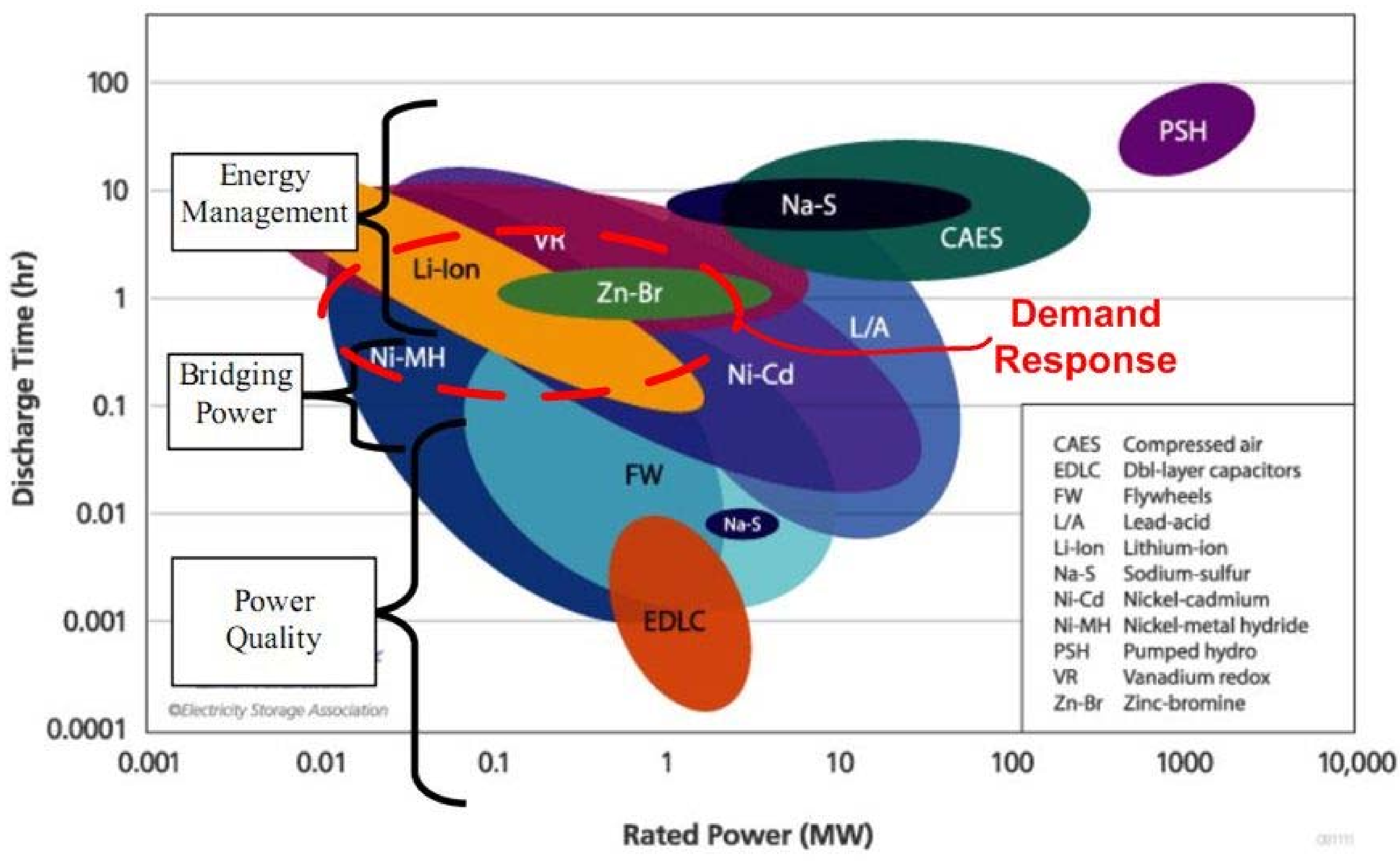
AutoDR for Existing CAISO products	Service	Response Time	Duration
AutoDR	Reg Up	Start <1 min. Reach bid <10 min	15 - 60 min
AutoDR	Reg Down	Start <1 min. Reach bid <10 min	15 - 60 min
AutoDR	Non-Spin	< 10 min	30 min
Future	Spin	~ Instant Start Full Output <10 min	30 min

Demand Response Opportunities:
Advance Notice and Duration of Response



AutoDR Terminology & Link to Batteries

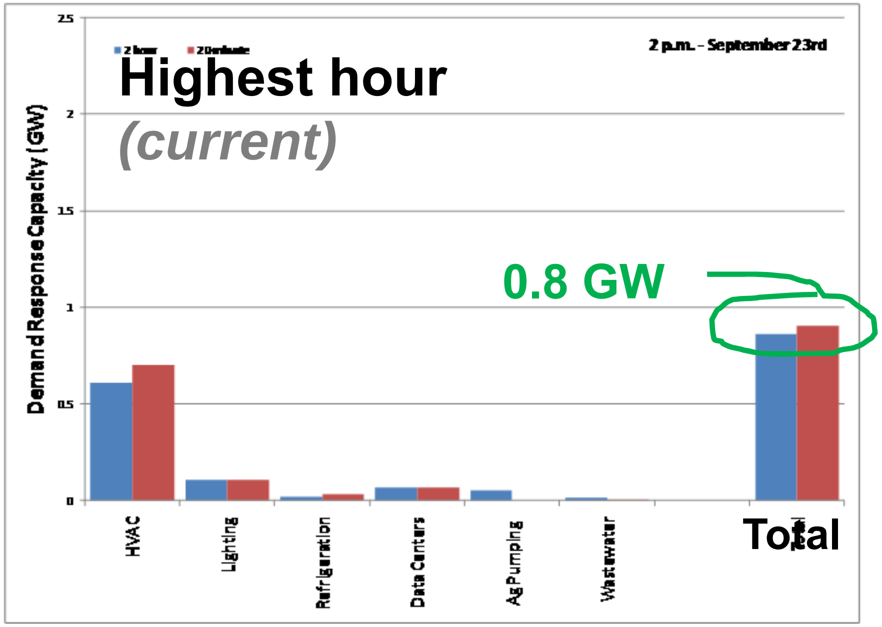
Shed	Energy reduced during specified period (e.g., reduced lighting) - net energy reduction
Shift	Energy moved to different time period- minimal change in consumption
Charge	Energy use to store load (e.g., pre-cool or charge batteries)
Discharge	Energy storage supplies local loads (thermal or electrical) or provides power to grid

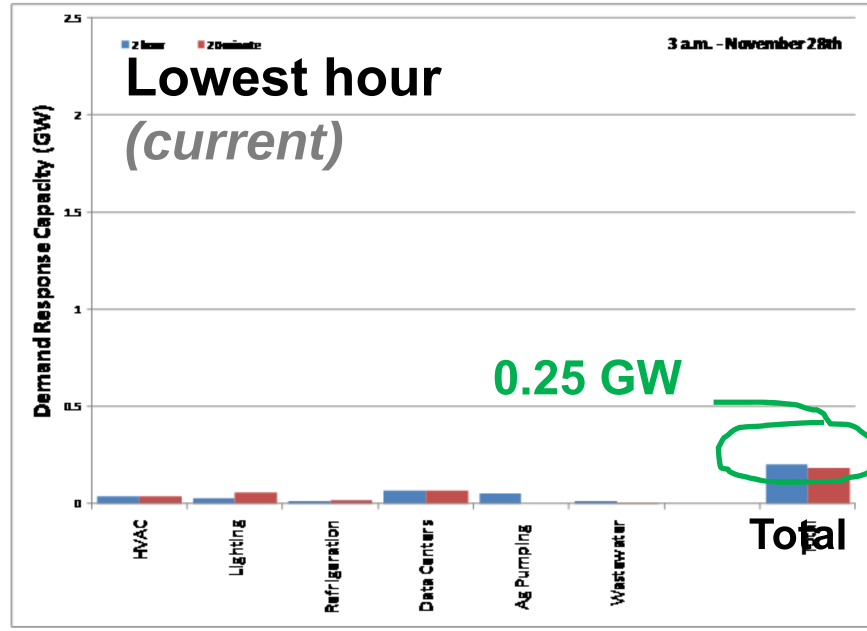


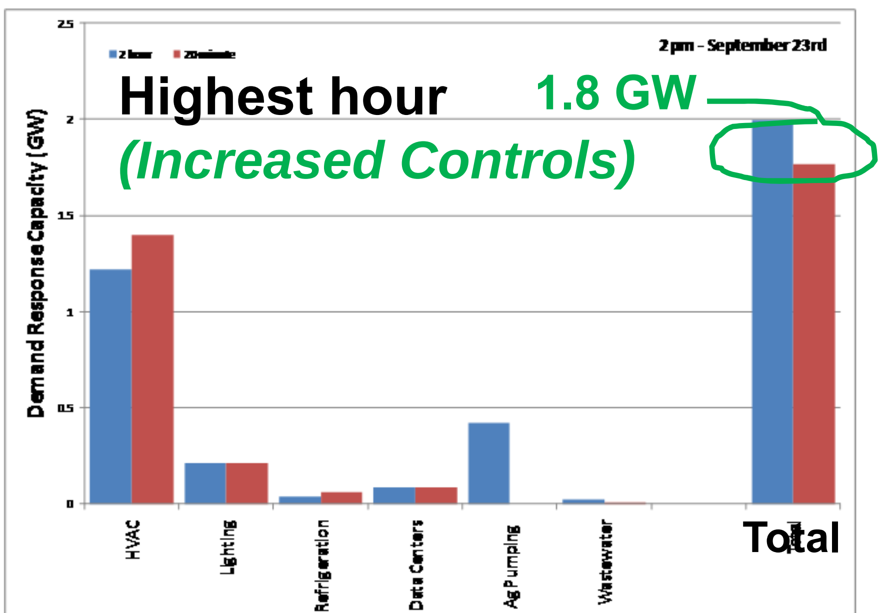
End Uses & Response

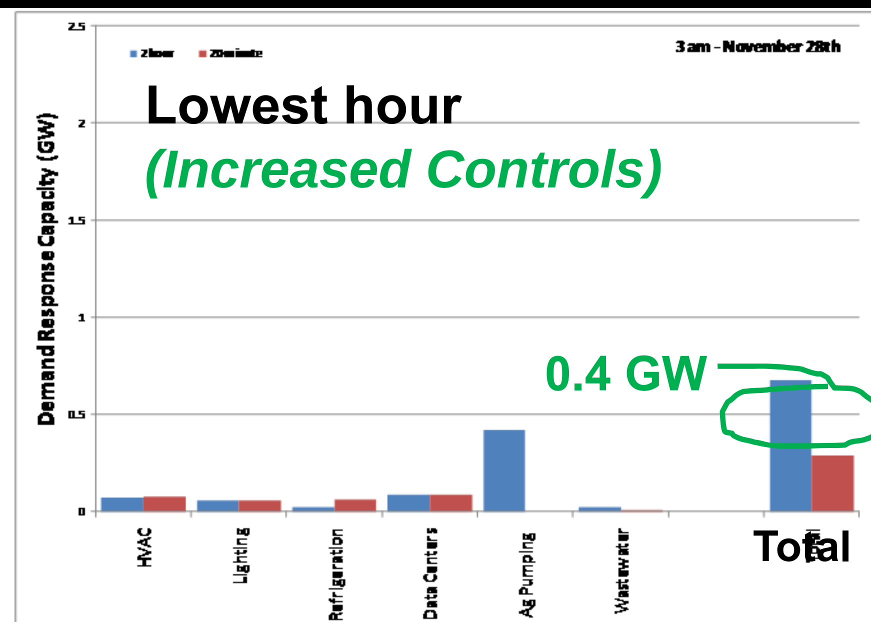
End Use	Type	Modulate	On/Off	Max. Response Time
HVAC	Chiller Systems	Setpoint Adj.		15 min.
	Package Unit	Setpoint Adj.	Disable Compressors	5 min.
Lighting	Dimmable	Reduce Level		5 min.
	On/Off		Bi-Level Off	5 min.
Refrig/Frozen Warehouse		Setpoint Adj.		15 min.
Data Centers		Setpoint Adj., Reduce CPU Processing		15 min.
Ag. Pumping			Turn Off selected pumps	5 min.
Wastewater			Turn Off selected pumps	5 min.

Shed Estimates: Highest & Lowest hours of the Year

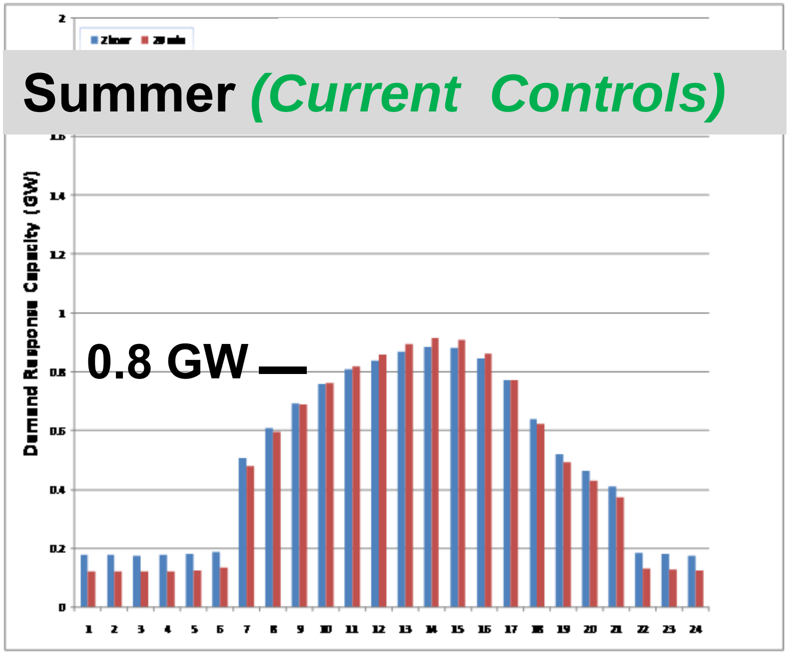


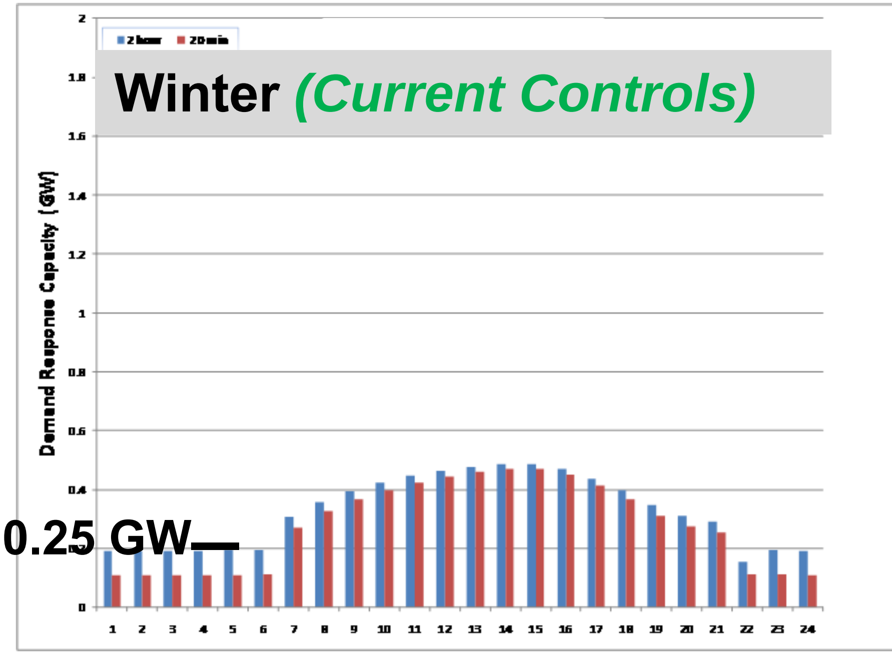


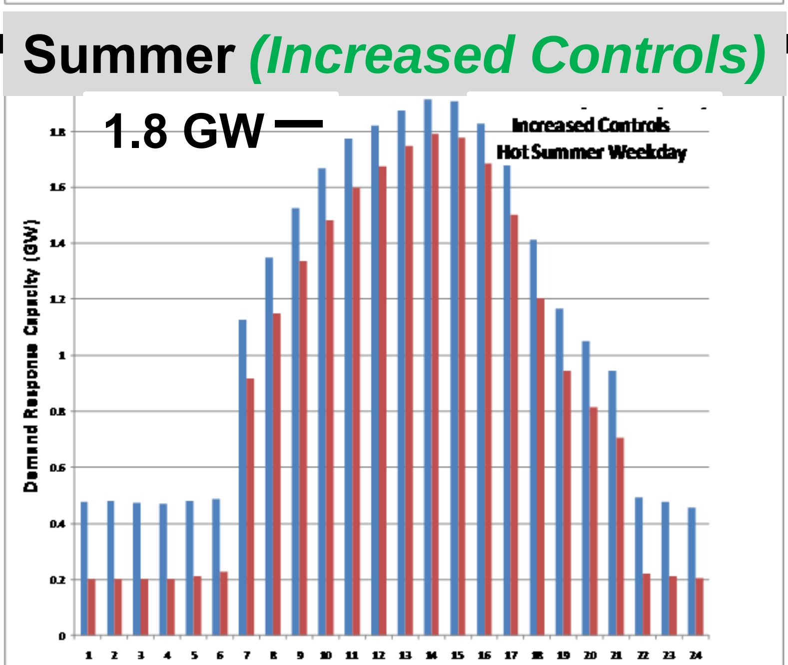


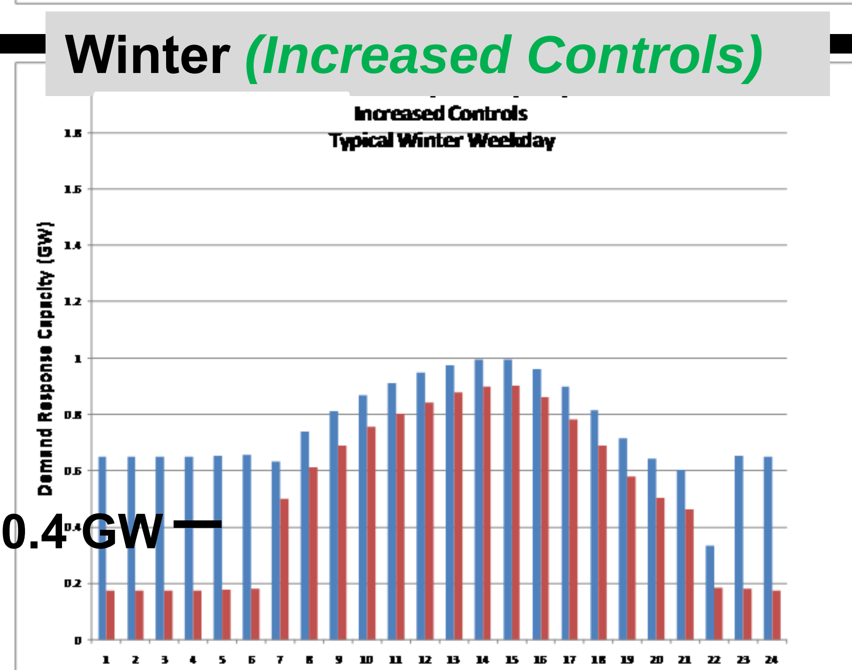


Shed Estimates: Summer & Winter 24 hr. Profiles









Conclusions & Future Research

Conclusions

Preliminary estimate: AutoDR could provide 0.25 to 0.8 GW of AutoDR ancillary services in the existing stock throughout CA

Investments to improve controls that are currently “unreachable” to AutoDR could double the shed potential to 0.4 to 1.8 GW

Future research

- Economic evaluation
- Additional off-peak data from field tests & surveys
- Geographic considerations

Auto-DR for Ancillary Services and Integration of Intermittent Renewable Resources: PG&E Pilots

How can Auto-DR help Intermittent Renewable Resources?

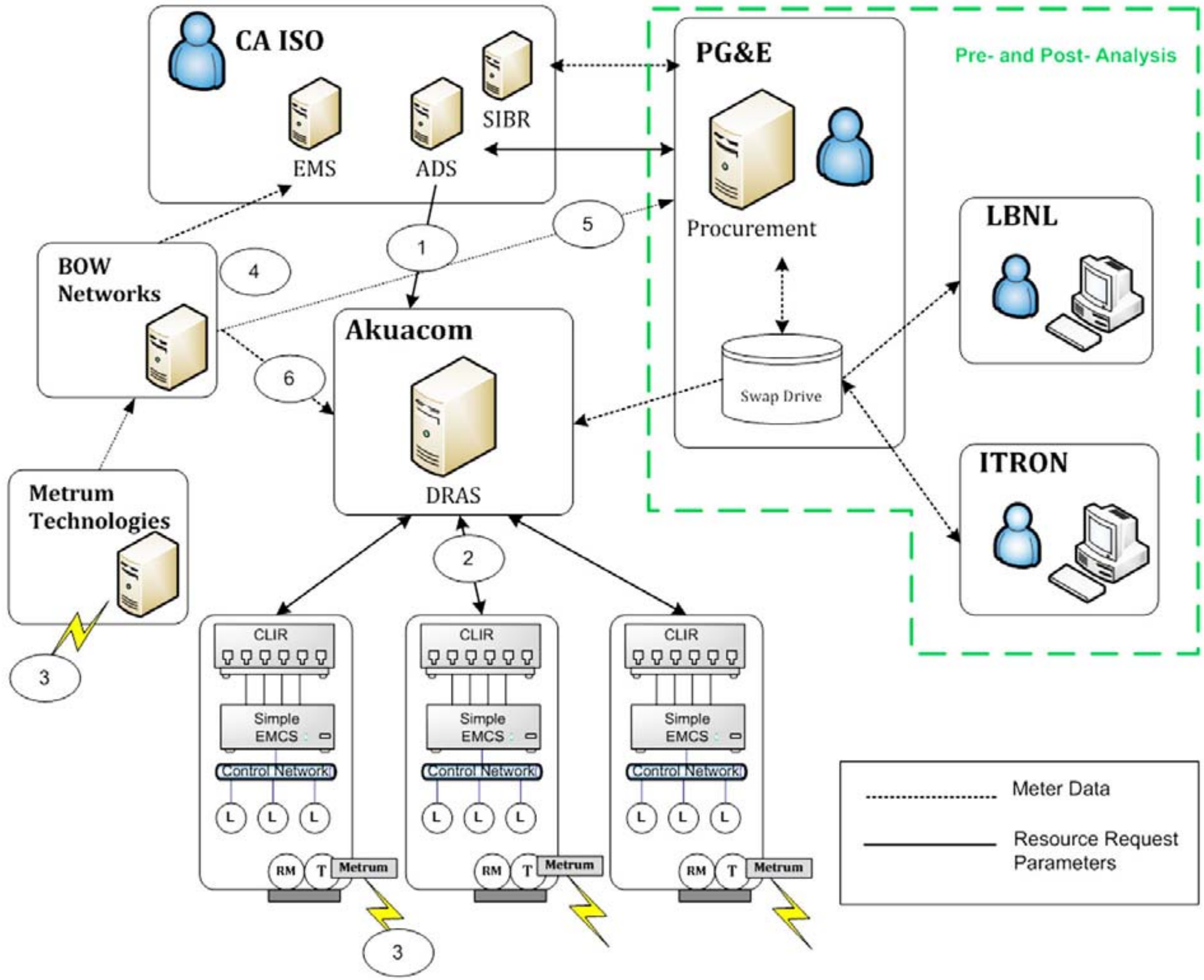
Activities

- PG&E has started to look at the technical feasibility of providing various services to the California Independent System Operator (CAISO) to mitigate against the following:
  - Increasing Ramping Requirements
  - Over Generation
  - Intra-hour variability
- Two pilots over the course of the 2009 – 2011 Demand Response (DR) Cycle to address feasibility of providing services to CAISO.

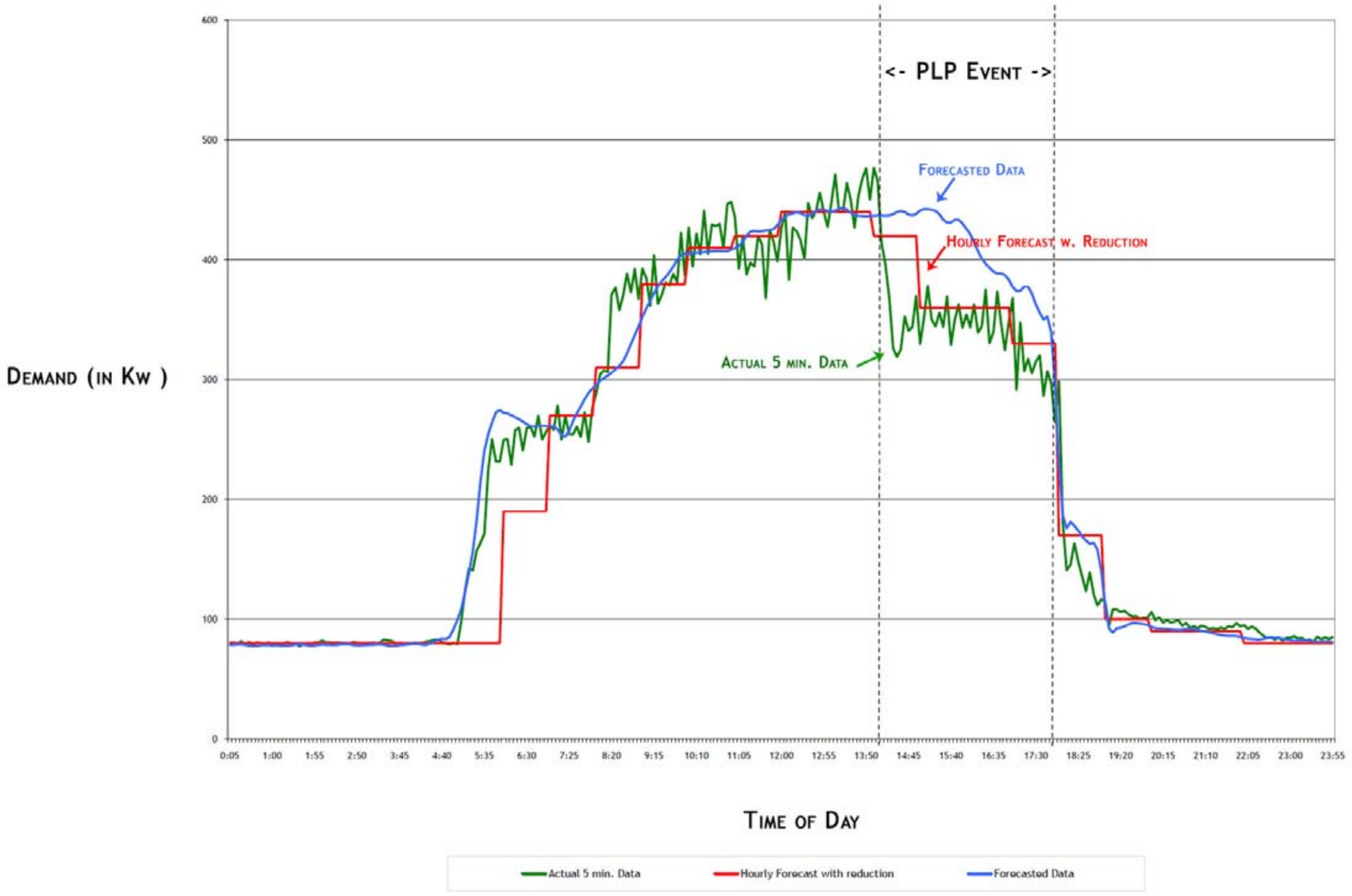
2009 Participating Load (PL) Pilot

- The PL Pilot was able to demonstrate the following:
  - Integration with CAISO's Automated Dispatch System (ADS) with Auto-DR's Demand Response Automated Server (DRAS)
  - Creation of a 'feedback' mechanism to allow customer resources to provide close to the instructed supply (demand reduction) by the CAISO

PLP Architecture



PLP Event



<- PLP Event ->
Forecasted Data
Hourly Forecast w. Reduction
Actual 5 min. Data
Demand (in Kw)
Time of Day
600
500
400
300
200
100
0
0:05 1:00 1:55 2:50 3:45 4:40 5:35 6:30 7:25 8:20 9:15 10:10 11:05 12:00 12:55 13:50 14:45 15:40 16:35 17:30 18:25 19:20 20:15 21:10 22:05 23:00 23:55
Actual 5 min. Data
Hourly Forecast with reduction
Forecasted Data

2010-2011 Intermittent Renewable Resource (IRR) Pilot

- The IRR Pilot will demonstrate the following:
  - Whether the coupling of DR with imbedded or thermal energy storage can provide regulation up/down and 5 minute real time energy services to the CAISO
  - Integration with CAISO's Automatic Generator Control (AGC) with Auto-DR's Demand Response Automated Server (DRAS)
  - Analyze the optimization of thermal energy storages and the possibility to provide various services that may be able to mitigate intermittency

Conclusion

- Based on the Pilots, Auto-DR technology may be able to provide the proper communication structure to interface with the CAISO or any other system operator (i.e., UDC, etc…)

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Demand Response

Wholesale market triggers in response to intermittent renewables

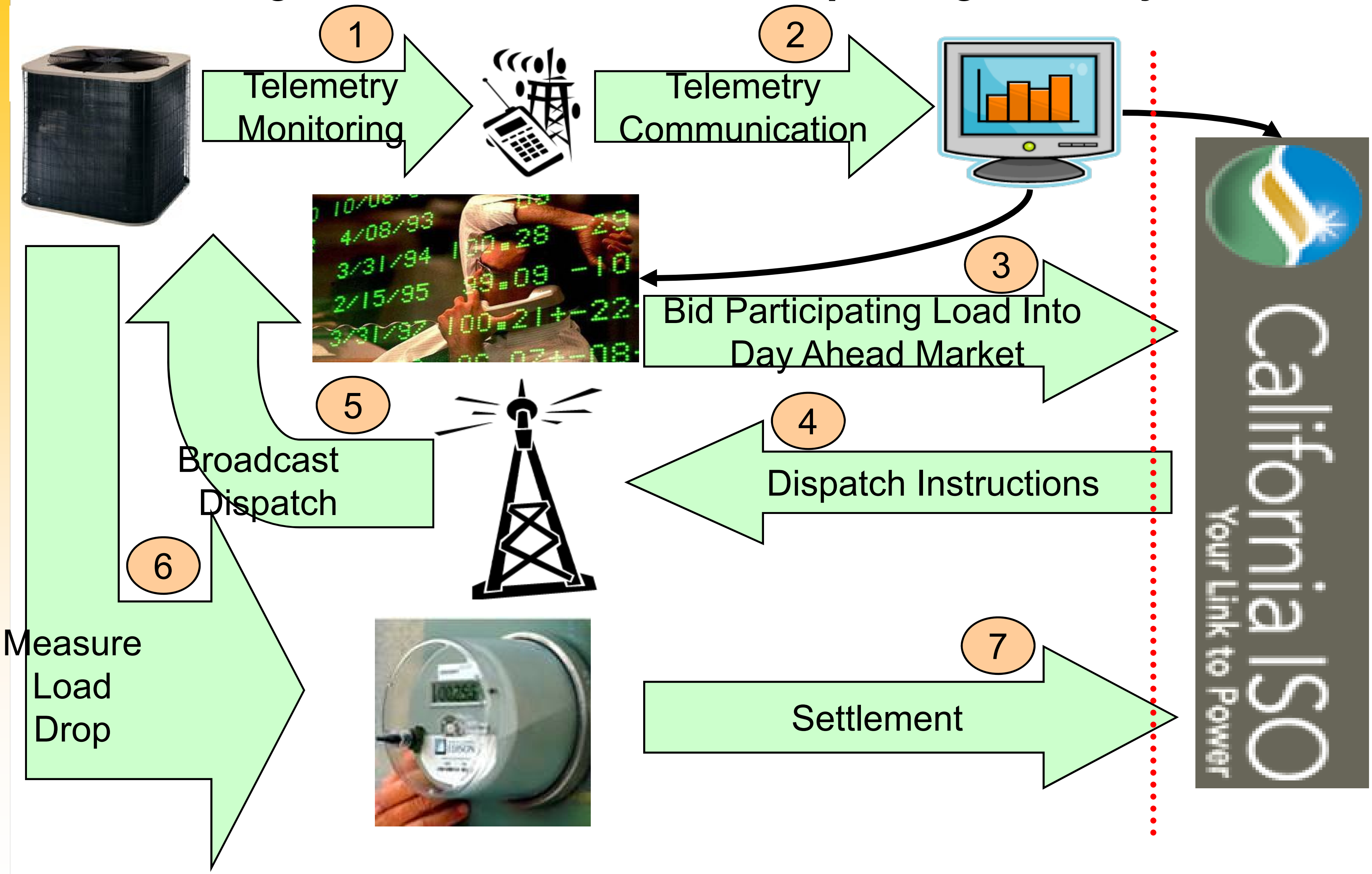
Wholesale markets for Demand Response

- **CAISO operates a series of procedures and markets that together comprise the CAISO Markets Processes.**
- **To further the CAISO goal to increase demand response (DR) participation in its wholesale electricity markets, the ISO has developed two new Demand Response product offerings:**
  - Proxy Demand Resource (PDR)
  - Reliability Demand Response Product (RDRP)
- **A Scheduling Coordinator (SC) that represents a PDR can bid into the following markets:**
  - Day-ahead energy market including Residual Unit Commitment (RUC)
  - Day-ahead and Real-Time Non-Spinning Reserve market
  - 5- Minute Real-Time Energy market
  - And eventually the Hour-Ahead Scheduling Process (HASP) after a significant implementation effort

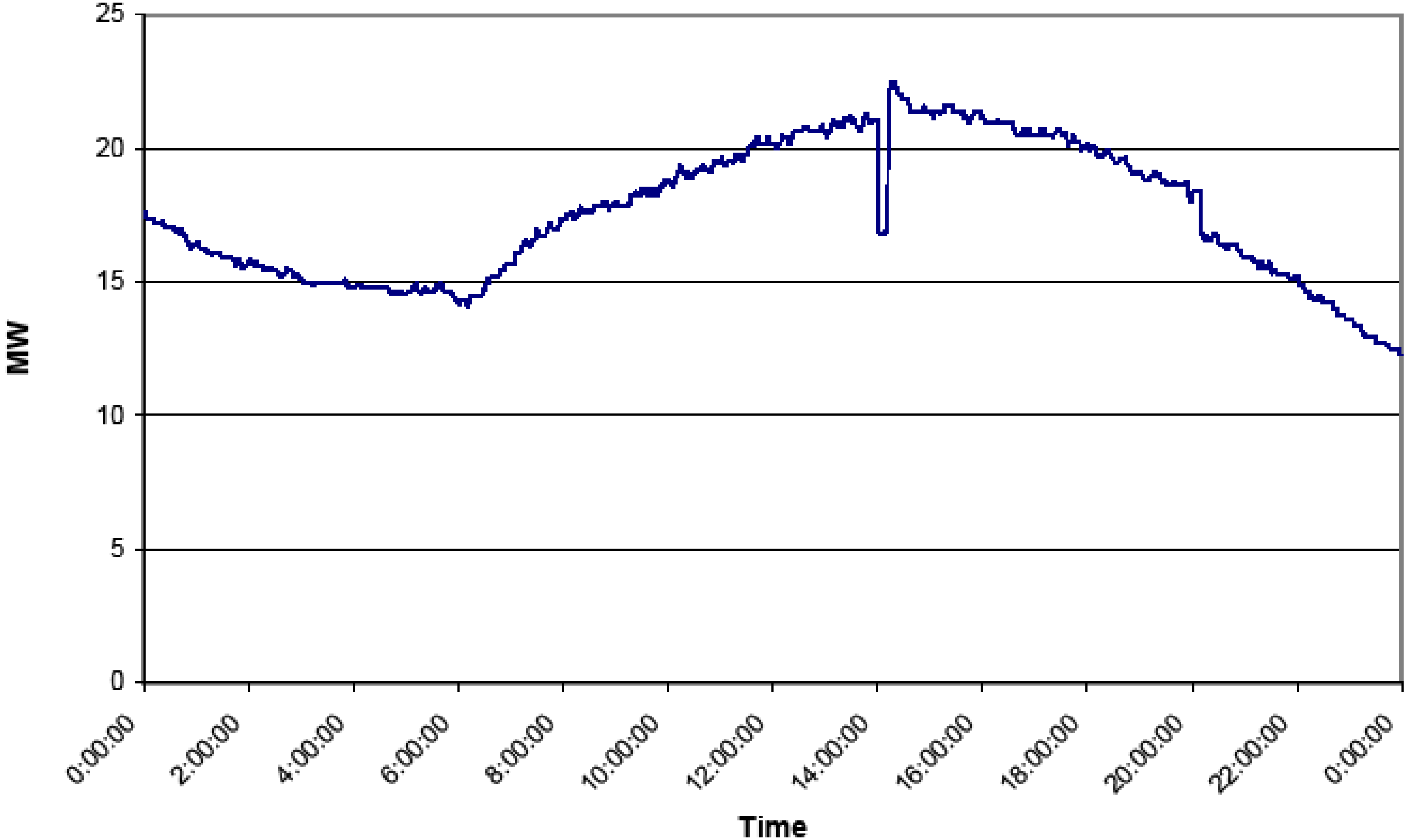
DR as a Contingent Ancillary Service

- **An Ancillary Service (AS) resource can be registered as a "contingent" resource**
  - Contingent resources are made available in the market when another resource does not perform as scheduled
  - This mechanism will likely be utilized to trigger DR or other contingent AS resources when intermittent renewables do not perform as scheduled
- **There are challenges for DR to provide AS**
  - IOUs working with CAISO to address alternative approaches for
    - Telemetry providing 4 second or 1 minute updates on resource load
    - 5 minute settlement (when retail meters have 15 minute or 1 hour intervals)
  - Determining the retail compensation for customer participation in a wholesale market product
    - CPUC DR OIR Phase IV Part 2 will address some of these issues
- **Automated Demand Response (AutoDR) is required in order for customers to react quickly enough to respond to AS dispatches**
  - SCE utilizes OpenADR through the Internet for large commercial & industrial customers
  - SCE will utilize ZigBee Smart Energy Profile 2.0 (SEP 2.0) enabled through Edison SmartConnect™ for residential and small/medium commercial & industrial customers
  - OpenADR & SEP 2.0 are NIST identified standards for Smart Grid

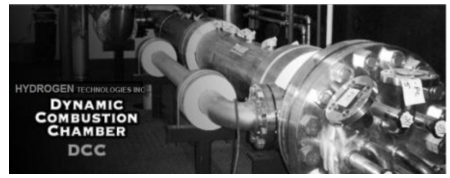
Pilot testing of A/C load DR as a Non-Spinning Ancillary Service



Typical dispatch from 2009 pilot with 3200 A/C units



HYDROGEN TECHNOLOGIES, INC.



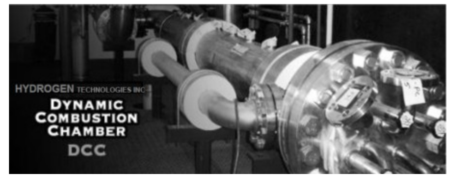
To: Avtar Bining, Ph.D.
Program Manager (Energy Systems Research - Smart Grid, Energy Storage, DER/DG)
California Energy Commission
Energy Research & Development Division
1516 - 9th Street, MS-43
Sacramento, CA 95814-5512

Re: Comments to Staff Workshop on Energy Storage and Automated Demand Response Technologies to Support Renewable Energy Integration

Hydrogen Technologies, Inc. (HTI) has a revolutionary boiler that is called the Dynamic Combustion Chamber, (DCC). This brand new boiler provides an alternative to current boiler technology. Current technology uses atmospheric oxygen containing 78% nitrogen which generates nitrogen oxides upon combustion, a green house gas. Alternatively, HTI's DCC technology uses ***pure oxygen*** when burning hydrogen, methane, ethane or natural gas. No nitrogen is introduced in the HTI DCC Boiler process and therefore nitrogen oxides are not formed, thus eliminating the harmful greenhouse gas emissions and related air permits and fees.

The HTI DCC Boiler delivers energy in the form of steam for heating, cooling and power production. This new boiler does not require an air permit when burning pure hydrogen and significantly less permitting when burning methane, ethane, and natural gas relative to other existing boiler technologies.

The HTI DCC Boiler can utilize stored hydrogen generated from water electrolysis from renewable power to convert the stored energy through a thermal hydrogen process to create steam on demand for electrical generation. Turbo-expanders can be used in conjunction with the boiler to reduce hydrogen and oxygen storage pressures to boiler inlet pressures while driving a generator



for instantaneous delivery of power on the grid for Auto-DR. Steam turbine/generator can follow load accordingly.

The distributive nature and variable size capability of the HTI DCC Boiler, the water electrolysis system and storage allows for this system to be placed anywhere on the grid for target grid control. Mobile units can even be deployed.

Burning pure hydrogen with pure oxygen is HTI's cleanest burning boiler.

Pure hydrogen can be made by one of the following conventional processes:

1. Water electrolysis
2. Steam reformation or
3. Gasification.

Pure oxygen can be made by using the same process for hydrogen, via water electrolysis, or by another conventional process called air separation.

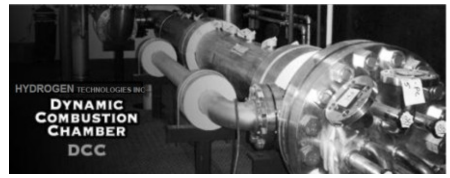
When burning methane, ethane or natural gas as a fuel in the HTI DCC Boiler with pure oxygen the only products of combustion are water and carbon dioxide. Carbon dioxide can be sold for \$0.75/lb to \$1.25/lb whereas pure oxygen can be made for as little as \$0.02/lb.

The HTI DCC Boiler allows boiler owners who are in the process of upgrading natural gas boilers to convert to the HTI DCC Boiler now without significant cost. In the future they can convert to hydrogen only, in order to hedge unforeseen natural gas price increases, avoid fuel interruptions or permit changes.

Additionally, the HTI DCC provides protection from:

1. Cap and Trade[1]
2. Acid Rain Program[1]
3. NOx Budget Trading Program[1]
4. European Carbon Dioxide Trading Programs[2] or
5. California's Cap and Trade Program[3]

by eliminating or reducing criteria pollutants from the boilers emission profile.

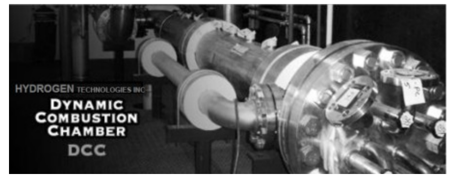


Our solutions offer the following:

- Allows for fuel diversity.
- Ability to harvest and "bank" off-peak energy from traditional sources such as hydroelectric dams, then storing the energy as hydrogen and utilizing the fuel during peak periods to generate power.
- Method of generating predictable and focused (on peak) power from hydrogen produced by wind, solar and water movement sources which are more variable in nature.
- Instantaneous delivery with load following capability.
- Steam generation for commercial heating and cooling, sterilization and pasteurization, waste water purification and sea water desalinization, manufacturing, marine or other industrial applications.
- Small, medium and large units for centralized or distributed power generation.
- Small units can be placed in automobile stations serving both the hydrogen highway, renewable energy storage and Auto-DR needs.
- No air permit required for the hydrogen only model and significant reductions in permit conditions for natural gas models.
- Utilizes proven conventional power plant technology.
- Durable with long life expectancy, i.e. 50 to 80 years.

UC Davis' Hydrogen Utilization and Production Lab completed a technical validation and the patent has been awarded, Patent No. US7,546,732 B; Issued June 16, 2009.

HTI installed and operated the first commercial unit at the Plumbers and Pipefitters Local 442 in Modesto, CA[6]. The system is designed to supply enough power to operate the 22,000 square foot union hall and administration offices. The DCC has become a training and apprenticeship model for skills



development in advanced steamfitting and boiler technologies. Another HTI DCC Boiler has been ordered for the Plumbers and Pipefitters Local 246 in Modesto, CA[7].

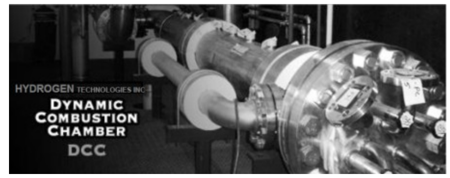
HTI request that our thermal hydrogen process be included for discussion and consideration with regards to the technologies able to support renewable energy integration such as energy storage and automated demand response (Auto-DR) technologies as a part of the 2011 Integrated Energy Policy Report (2011 IEPR) relating to energy systems and renewables in California.

We thank you for the opportunity to submit our comments and we look forward in participating in the successful deployment of renewable energy in California.

Sincerely,

Edward J. Stockton
President/CEO
Hydrogen Technologies Inc.
936 Russell Road
Modesto, CA 95358-8207
Ph: (209) 986-9346

1) http://www.epa.gov/capandtrade/
2) http://en.wikipedia.org/wiki/European_Union_Emission_Trading_Scheme
3) http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm
4) http://www.bsria.co.uk/news/2006/
5) http://www.eia.doe.gov/iea/elec.html
6) http://lu442.com/



7) http://www.ualocal246.com/

Pacific Gas and Electric Company

Dan Patry
State Agency Representative
State Agency Relations

77 Beale Street, MC B10B
San Francisco, CA 94105
(415) 973-6146
Fax: (415) 973-2672
DBP0@pge.com

December 2, 2010

Electronic Delivery

California Energy Commission
Dockets Office, MS-4
1516 Ninth Street
Sacramento, CA 95814

Re: Docket No. 11-IEP-1N

Docket Office:

Please find attached PG&E's comments on Technologies for Renewable Integration workshop, held November 16, 2010. Please contact me should you have any questions.

Sincerely,

Attachment

Pacific Gas and Electric Company Comments in Response to the November 16th Staff Workshop on Energy Storage and Automated Demand Response Technologies to Support Renewable Energy Integration
Docket No. 11-IEP-1N

Pacific Gas and Electric Company (PG&E) appreciates the opportunity to participate in the California Energy Commission (CEC) staff's discussion surrounding the status of energy storage and Automated Demand Response (Auto-DR) technologies. PG&E also appreciates the hard work that the CEC and other stakeholders have done to contribute to this dialogue and to address these issues.

Energy storage technologies have the potential to increase the reliability and dispatchability of California's energy supply. The electricity grid of the future will need energy storage, automated demand response (e.g. Auto-DR enabled demand side resources), and other flexible resources to integrate variable renewables, provide ancillary services, manage peak demand, and relieve transmission and distribution congestion. As workshop participants showed, energy storage and Auto-DR solutions provide multiple products which are necessary to address California's future energy system challenges. However, many emerging technologies are not proven, especially on a utility scale.

Successful deployment of energy storage will depend on things like technology readiness, improved understanding of the costs and benefits of storage, funding for the demonstration of emerging technologies (i.e. batteries, flywheels, etc.), funding for established, long lead time technologies (i.e. pumped storage and possibly Compressed Air Energy Storage (CAES)), and a deeper discussion of market rules and policy recognition of storage. Addressing these issues will help enable more storage deployment in California.

PG&E encourages the CEC's efforts to make an honest assessment of the feasibility and cost of storage options which can be deployed to achieve 33% renewables by 2020. As indicated at the workshop, a study that consistently evaluates the costs and benefits of different storage benefits would be useful to sort out which storage options are available, and at what costs, to integrate higher levels of intermittent renewable resources.

PG&E also encourages continued funding of energy storage and Auto-DR technologies that need development and demonstration funding. Specifically Auto-DR technologies, including communication technologies and control technologies on customer side such as lighting/HVAC controls, need to be further developed to facilitate the enablement of faster demand response that will be required for the integration of renewable resources.

With respect to the suggestion that energy storage be added to California's loading order, PG&E believes such action would be counterproductive to the state having a cost-effective infrastructure for a 33% RPS resource portfolio. PG&E instead favors an honest evaluation of storage options, compared to other alternatives available to provide the system with the necessary operating flexibility to integrate higher renewable levels. Such a change would certainly be premature before the CPUC concludes its AB 2514-mandated proceeding to determine appropriate storage targets, if any, for each load-serving entity.

While storage is getting significant attention for use in integrating renewables, it should be a recognized that it would be most effectively used as a complementary part of a diverse portfolio that includes Auto-DR enabled resources and other flexible resources.

CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

December 17, 2010

DOCKET
11-IEP-1
DATE DEC 17 2010
RECD. DEC 20 2010

E-mail to docket@energy.state.ca.us

Presiding Member: Chairman Karen Douglas
Associate Member: Jeffrey D. Byron

Original copy to
California Energy Commission
Docket Office, MS-4
Re: Docket 11-IEP-1
1516 Ninth Street
Sacramento, CA 95814-5512

Re: **Comments of the California Energy Storage Alliance on 2011 Integrated Energy Policy Report ("IEPR") Committee Scoping Memo**
Docket 11-IEP-1

Dear Chairman Douglas and Associate Member Byron:

The California Energy Storage Alliance ("CESA") is pleased to submit these comments that relate to both the November 16 Workshop on Energy Storage and Automated Demand Response Technologies to Support Renewable Energy Integration and the November 23 Joint Committee Workshop on Electricity Infrastructure Need Assessment.

CESA appreciates your efforts to explicitly address energy storage and its role in supporting renewable integration. The Workshops are consistent with the direction provided in the July 12, 2010 scoping memo which noted that "An important subtopic in the 2011 IEPR will be energy storage as it relates to integrating preferred resources into the electricity system." Both Workshops are also timely, given the recent enactment of AB 2514 and the CPUC's rapid response to begin implementation of this historic new legislation.[1] Further, the ongoing Long Term Procurement Planning effort at the CPUC will similarly benefit from the CEC's policy leadership in this area.

Given the CEC's already established leadership with respect to energy storage, as noted above, CESA was dismayed to see that the November 23 Joint Committee Workshop on Electricity Infrastructure Need Assessment came to a different and perplexing conclusion. In particular, on pages 31, 35 and A-5 the document states: "Reference to dispatchable fossil resources does not negate the possible role that storage technologies might play in satisfying some portion of the

[1] Order Instituting Rulemaking was unanimously approved by the CPUC on December 16, 2010.

needs currently carried by dispatchable fossil generation. However, there is no standardized manner of describing the specific capabilities of 'storage' or its degree of control by system operators. Absent this, ***ESAD assumes that storage remains a niche or R&D technology with promise, but not yet able to play a substantive role in displacing dispatchable fossil generation.***" (Page A-5).

CESA strongly disagrees with this latter statement. Storage *can and will* play a significant role in displacing dispatchable fossil generation. This case has been made by the CEC as recently as this past summer in the report titled "Research Evaluation of Wind Generation, Solar Generation and Storage Impacts to the California Grid (CEC-500-2010-010). Key conclusions of this report (source pages 15-16) include:

> Large - scale storage can improve system performance by providing regulation and imbalance energy for ramping or load following capability.
>
> Increasing regulation amounts, without the use of storage and improved control algorithms, can improve system performance. However, roughly 2 - to - 10 times the amount of today's regulation and balancing capacity would be required to maintain system performance absent other operating protocols, such as limiting ramp rates and new services that could be developed as alternatives to address renewable ramping as well as scheduling and forecasting errors.
>
> Existing battery technologies appear to have the capabilities required to manage renewable integration, including two - hour durations and ramping capabilities of 10 MW/second or greater.
>
> On an incremental basis, storage can be up to two to three times as effective as adding a combustion turbine to the system for regulation purposes.

The CPUC also supports the near term evaluation and inclusion of energy storage in California's electric power system as noted in the new Energy Storage OIR:

> "Although the Legislature has given the Commission until March 1, 2012 to open this proceeding, we see the enactment of AB 2514 as an important opportunity for this Commission to continue its rational implementation of advanced sustainable energy technologies and the integration of intermittent resources in our electricity grid." (Page 1, OIR)

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The role of energy storage was also formally addressed in the CPUC's July Policy document titled "Electric Energy Storage: An Assessment of Potential Barriers and Opportunities"[2]. For example, the Introduction of this report states:

> "…a promising new set of Electric Energy Storage ("EES") technologies appear to provide an effective means for addressing the growing problem of reliance on an increasing percentage of intermittent renewable generation resources."
>
> "California policymakers support the development of EES because it can provide an advantageous strategy for meeting the state's long-term clean energy goals while maintaining system reliability."

Pursuant to AB 2514, the CEC also has a number of specific rights and responsibilities with respect to Publicly Owned Utilities: Publicly owned electric utilities serving end use customers must:

- on or before March 1, 2012, initiate a process to determine appropriate targets, if any, to procure viable and cost-effective energy storage systems to be achieved by December 31, 2016, and December 31, 2021.
- reevaluate the procurement determinations they have made not less than once every three years.
- report to the Energy Commission regarding energy storage system procurement targets and policies adopted by their governing boards and report any modifications made to those targets as a result of any reevaluation.
- submit a report to the Energy Commission demonstrating that they have complied with energy storage system procurement targets and policies adopted by their governing boards.
- by January 1, 2022, submit a report to the Energy Commission demonstrating that they have complied with energy storage system procurement targets and policies adopted by their governing boards.
- upon request, provide the Energy Commission with any information the Energy Commission determines is necessary to evaluate their progress.

[2] www.cpuc.ca.gov/PUC/energy/reports.htm

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The Energy Commission must:

- In reviewing the plans and reports submitted by public electric utilities:

  (a) Consider existing operational data and results of testing and trial pilot projects from existing energy storage facilities.

  (b) Consider available information from the California Independent System Operator derived from California Independent System Operator testing and evaluation procedures.

  (c) Consider the integration of energy storage technologies with other programs, including demand-side management or other means that will result in the most efficient use of generation resources and cost-effective energy efficient grid integration and management.

  (d) Ensure that the energy storage system procurement targets and policies that are established are technologically viable and cost effective.

- ensure that copies of plans and reports are available on the Energy Commission's internet web site, or on an internet web site maintained by publicly owned electric utilities that can be accessed from the Energy Commission's internet web site.

- report to the Legislature, to be included in each integrated energy policy report prepared pursuant to Section 25302 of the Public Resources Code, regarding the progress made by each publicly owned electric utility serving end-use customers.

Finally, the timing for including energy storage as a fundamental component of California's electricity infrastructure has never been greater. At the November 30, 2010 CPUC LTPP workshop, CAISO presented their findings related to full RPS Implementation, and found that the 33% in state RPS scenario resulted in a small INCREASE in MMBTU of fuel burn in California. According to Mark Rothleder, Director of Market Analysis and Development CAISO, "The primary reasons for this are a result of two things:

1) increased regulation and load following requirements resulting in resources with flexibility being committed online more in the 33% reference case over other cases and

2) lower level net imports from outside of CA in the 33% reference case. This result may change for depending on the ultimate source of flexibility."

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As you know, CESA made a presentation at the November 16 Workshop that set out a number of additional specific recommendations for consideration going forward. CESA thanks you very much for providing a comprehensive and thoughtful Scoping Memo, and looks forward to continuing our active participation with you and your staff on the 2011 IEPR.

Respectfully,

JANICE LIN
COFOUNDER AND DIRECTOR

cc: Suzanne Korosec, CEC, Assistant Director for Policy Development,
via e-mail: skorosec@energy.state.ca.us

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