

As the DR market has evolved, PLMA has grown with it:

**PLMA™**  
Demand Response Leadership Since 1999  
**2015**  
a year of growth for PLMA!

**GREW MEMBERSHIP**  
↑ **20%**  
by 20% to 91 members, PLMA's membership has more than **doubled** since 2012.

**INCREASED CONFERENCE ATTENDANCE**  
with Spring and Fall conferences attracting **308 attendees**, who learned about new trends, success stories and learning opportunities in the DR market.

**BROADENED PROFESSIONAL DEVELOPMENT OPPORTUNITIES**  
by launching a **3 part Demand Response training series**, drawing high scores from attendees.

**SUPPORTED INCREASED PARTICIPATION**  
in more than **34 member activities**, including conferences, training, DR Dialogues, Member Meet Ups and interest group meetings with **over 1,400 individuals participating** - an **86% increase** over 2014 levels.

**ADDED 4<sup>TH</sup> INTEREST GROUP**  
Distributed Energy Resources (DER) Integration, and transformed the **QIRWH** group to the **Grid-Interactive Behind-the-Meter Storage** interest group.

**EXTENDED REACH**  
through **strategic alliances** with important peer organizations: **AESP, MESA** and the Smart Grid Consumer Collaborative (**SGCC**).

**EXPANDED MEMBER SERVICES AND OPERATIONS**  
by adding a **member services director**.

**RAISED PROFILE**  
by publishing thought leadership articles on DR in **EnergyBiz** and **Electric Light & Power** magazines.

**1,400**  
INDIVIDUALS PARTICIPATING

PLMA continues to grow and expand our quality offerings to keep our members at the forefront of a fast-moving industry. We will build on this growth in 2016!


**PLMA™**  
Demand Response Leadership Since 1999

## Interest Group Discussions

### Women in DR Update

# Understanding the Storage and Demand Response Relationship

*Moderated by:*



**Gwen Resendes**  
Bonneville Power Administration

[www.peakload.org](http://www.peakload.org)

**PLMA**<sup>TM</sup>  
Demand Response Leadership Since 1999

## Interest Group Discussions

*Today's Presenters:*



**Beth Reid**  
Olivine, Inc.




**Anissa Dehamna**  
Navigant Research



**Elise Hunter**  
Pacific Gas and Electric  
Company

[www.peakload.org](http://www.peakload.org)



## An Approach to Integrating Demand Response Companion Measures

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Beth Reid, Olivine  
PLMA Women in DR Webinar  
May 26, 2016

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About Olivine and Community Solar Value Project

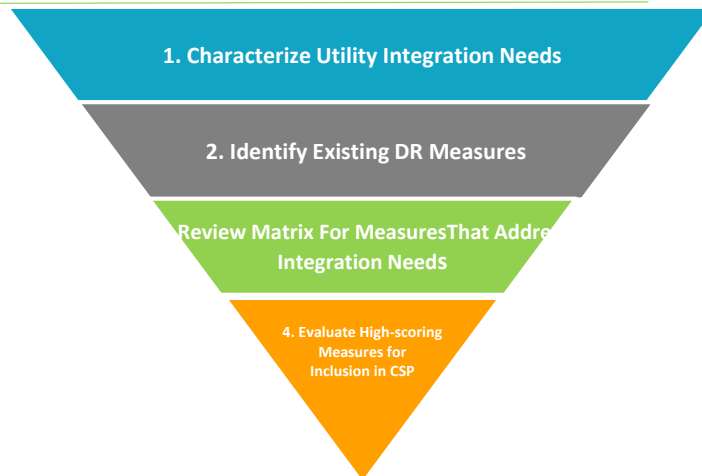
***Olivine is an industry leader in providing grid services market access through a unique blend of technology and services.***

- Working to increase the scale, reach, and value of utility-based community solar programs.
- Utilizes strategic solar technologies, siting, and design as well as integration of suitable companion measures, such as demand-response (DR) and storage.
- Helps to address solar variability, so that costly distribution-engineering solutions and regional-level ancillary services can be minimized.



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Process Overview



[www.communitysolarvalueproject.com](http://www.communitysolarvalueproject.com)

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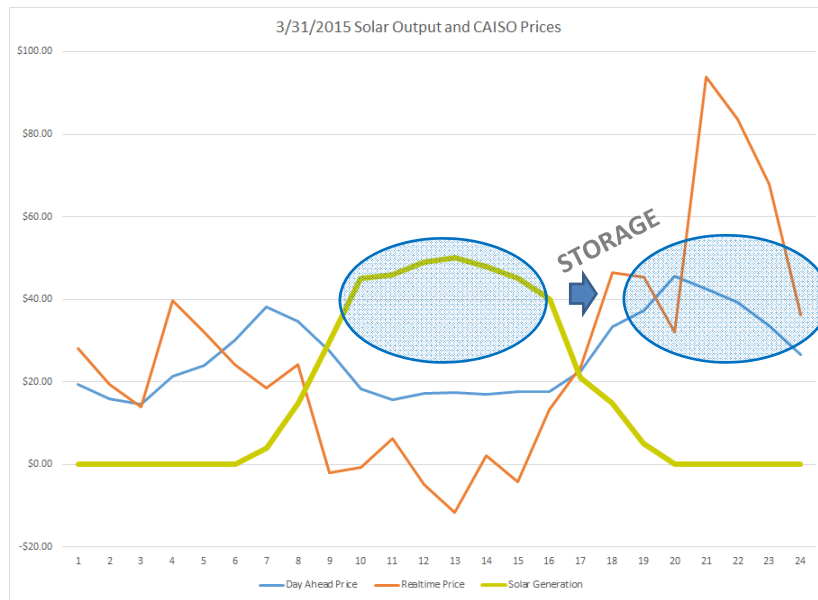
## Review Scoring Matrix For DR Measures That Address Integration Needs



Ability of DR Options to Address Integration					
Integration Issue	"Duck Curve" Issues	Intra Hour Fast Ramps	X>2-Hour Forecast Error	X>24-Hour Forecast Error	Peak Load Reduction
1 Direct Load Control	●	◐	◐	◐	●
2 Day-ahead Curtailable Load	◐	○	○	◐	●
3 Time-of-use-Rates	◐	◐	◐	◐	◐

●=High ◐=Medium/High ○=Medium ◑=Low ○=None

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## Project Examples

### Supply Side Pilot/Excess Supply Pilot



Aggregation of a variety of storage into CAISO DA and RT markets



### Optimal Pricing & Resource Allocation



Aggregation of EV charging stations and stationary batteries



### Sunna Project



PV coupled with water heater load control program



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## Sunna Overview

### Assets and Objectives

- SWCE serves 60MW of peak load and gets 15% of its energy from wind; water heating is 13-17% of residential energy consumption.
- Sunna Project CSP serves the distribution grid overseen by SWCE.
- Shift the load to aid the integration and therefore effective net value of wind and solar.

### Takeaways

- Coupling with water heater program minimized marketing expenses.
- Flexibility in charging times allows utility to avoid over generation.
- DR measures should be configured to grid conditions

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## CAISO Overview

- California Independent System Operator
- CAISO Markets:
  - Day-Ahead Energy
  - Real-Time Energy
  - Ancillary Services: Non-Spinning Reserve
  - Ancillary Services: Spinning Reserve



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## OPRA and SSP/XSP Overview

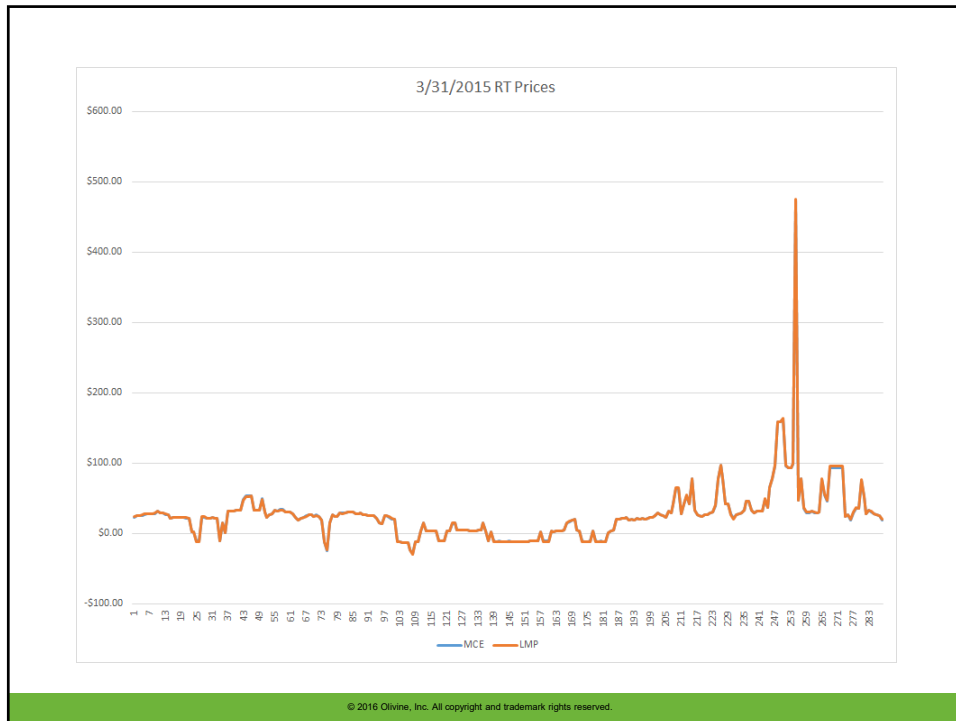
### Assets and Objectives

- 30 EV charges; 3 sets of stationary storage
- 10MW of resources (EVs, stationary batteries, traditional DR) both residential and C&I
- Provide DR service for consumption to address over-generation.
- Demonstrate the effectiveness of aggregated demand side resources to provide market based grid services

### Takeaways

- Underlying BTM technologies can be dispatched and respond on a very short time horizon.
- Customer who embrace renewables are aligned with embracing new technologies and behavioral changes not in traditional DR programs.
- Aggregated demand side resources are able to provide high value services such as frequency regulation.

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## DR Strategy Takeaways

- Heterogeneous aggregations are market compatible.
- Forecasting overall grid needs (as opposed to individual renewable output) was more effective in ensuring that DR measures fully aided integration and did not create unintended consequences.
- Fast responding demand side resources aid in renewable integration both as curtailment and consumption.



**Thank You.**

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**BATTERY ENERGY STORAGE AND  
DEMAND RESPONSE**

PREPARED FOR: WOMEN IN DR HOSTED BY PLMA

MAY 26, 2016

**NAVIGANT**



## SEVERAL DISTINCT MODELS FOR DR AND STORAGE

- Utility-Driven Models
  - Utilities procure residential storage for energy services (e.g. Sunverge)
  - Utilities procure commercial storage for energy services (e.g. Stem)
- Market-Driven Models
  - Develop commercial assets on a shared-saving or leasing scheme and bid into DR markets (e.g. Green Charge Networks or Stem)
  - Integrators sell commercial assets for cash and offer software upgrade to participate in DR markets in the future (e.g. Sharp Energy Solutions)

## UTILITY-DRIVEN ENERGY STORAGE FOR DEMAND RESPONSE EXAMPLES



- Sunverge has hundreds of units in production and under active management in Canada, the United States, Australia, New Zealand, South Korea and Germany. The company is installed at homes, multi-family dwellings, businesses, community centers and schools. Sunverge offers its Solar Integration System (SIS), an intelligent distributed energy storage system, combining batteries, power electronics, and multiple energy inputs in a UL-certified appliance controlled by software running in the cloud. Currently, Sunverge manages a cumulative 4.5 MWh of distributed storage, including projects listed below

### Projects Deployments

- Deployed a residential PV + energy storage project rated at 0.4 MWh in Queensland, Australia for energy cost management.

### Project Pipeline

- Developing a utility-scale project for residential storage rated at 1.84 MWh in Kentucky for energy cost management.



- Stem provides BTM energy cost savings coupled with aggregated grid services. They use 18 kW lithium iron phosphate battery modules connected in series to scale; systems have a small footprint, integrated forced air cooling for thermal management and strong monitoring and control features providing both host and utility grid services benefits. PowerScope software provides full control of individual sites as well as an aggregated fleet of systems. The software provides a visual interface, allowing a comprehensive view of system performance as well as current and future energy use.

### Projects Deployments

- Deployed a total of 0.6 MW in PG&E, SCE and SDG&E for energy cost management.

### Project Pipeline

- Developed a pipeline of 1 MW in Hawaii for energy cost management.
- Developed a pipeline of 8+ MW for energy cost management in California.
- Developed a pipeline of 85 MW in the West LA Basin for aggregated demand response energy storage in California as part of the SCE RFO under AB 2514.

## MARKET-DRIVEN ENERGY STORAGE FOR DEMAND RESPONSE EXAMPLES



- Green Charge Networks has been in BTM C&I ES since 2009, targeting retail clients and peak demand charge savings.
- The company operates on a shared savings model with financing known as a power efficiency agreement. They have partnerships with eVgo and Japan's Itochu Corporation, and they offer Li-ion battery system software controller is compatible with multiple Li-ion batteries that appear capable of being financed under their financing model.

**Project Deployments**

- In PG&E, 8 kW and in SDG&E, 5 kW for energy demand cost management

**Project Pipeline**

- In PG&E, 5.94 MW and in SCE, 5.44 MW for energy cost management
- In SDG&E, 2.54 MW for energy storage/solar PV integration

Green Charge Networks serves as the as system integrator with their GridSynergy software package (with advanced monitoring and smart controller) and Li-ion system provider to provide a modular and fully integrated ESS

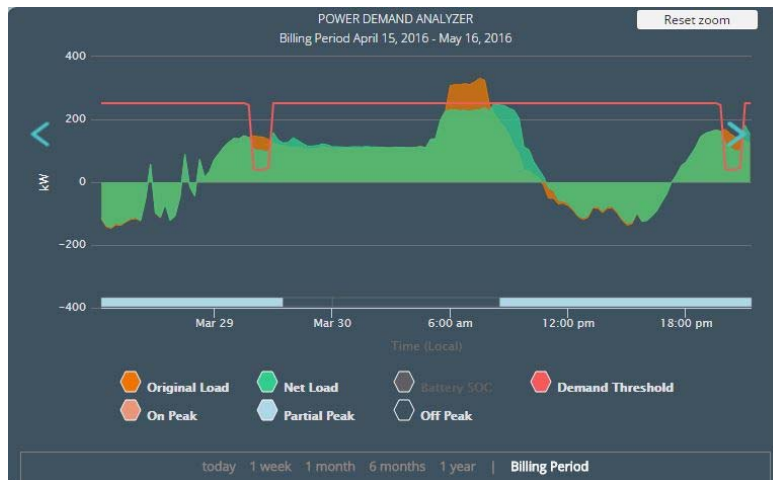
- Sharp Electronics Corp's Energy Systems and Services Group designed SmartStorage BTM ESS to reduce peak demand charges for C&I buildings.
- Sharp plans to install more than 50 MW of storage throughout the US, providing integrated Li-ion batteries (Samsung SDI cells), inverters (Ideal Power's bidirectional technology), software and controls. Like many other vendors, O&M package that includes 24-hour monitoring and cloud-based system access and control. Sharp has existing channel and financing partners to scale its business.

**Project Pipeline**

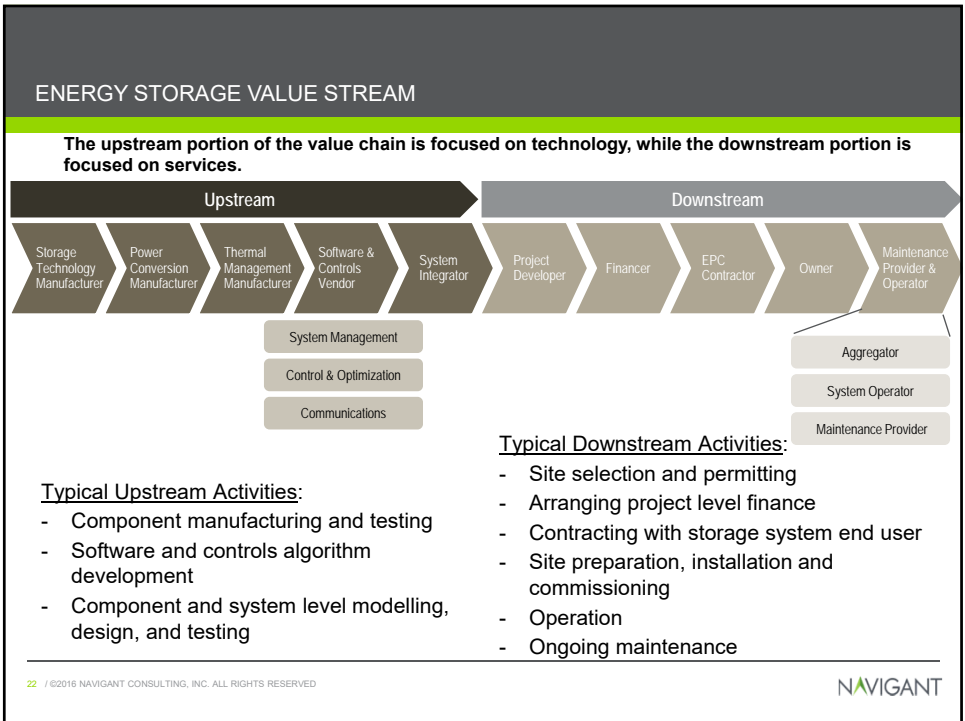
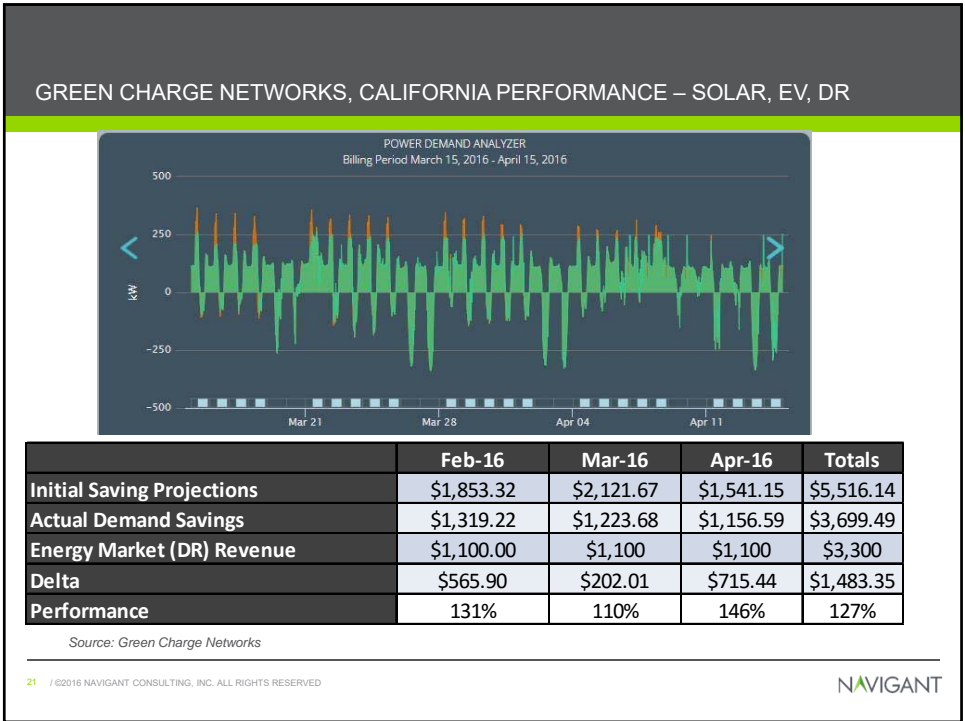
- In California, 48 kW of C&I BTM pipeline projects in announced in 2015 awaiting SGIP program funding and interconnection.

Sharp will act as the battery hardware vendor and provide the software management tools for both projects to manage peak demand charges. System is designed to integrate with solar PV.

## GREEN CHARGE NETWORKS, CALIFORNIA – SOLAR, EV, DEMAND RESPONSE



Source: Green Charge Networks



KEY BATTERY TECHNOLOGIES AND RELATED ISSUES

**Lithium-ion Batteries**

- Lithium ion cells are gaining market share due to a drop in price and their relatively flexible operating characteristics.
- Main issues include cycle life degradation with at elevated temperatures, cost, and thermal runaway

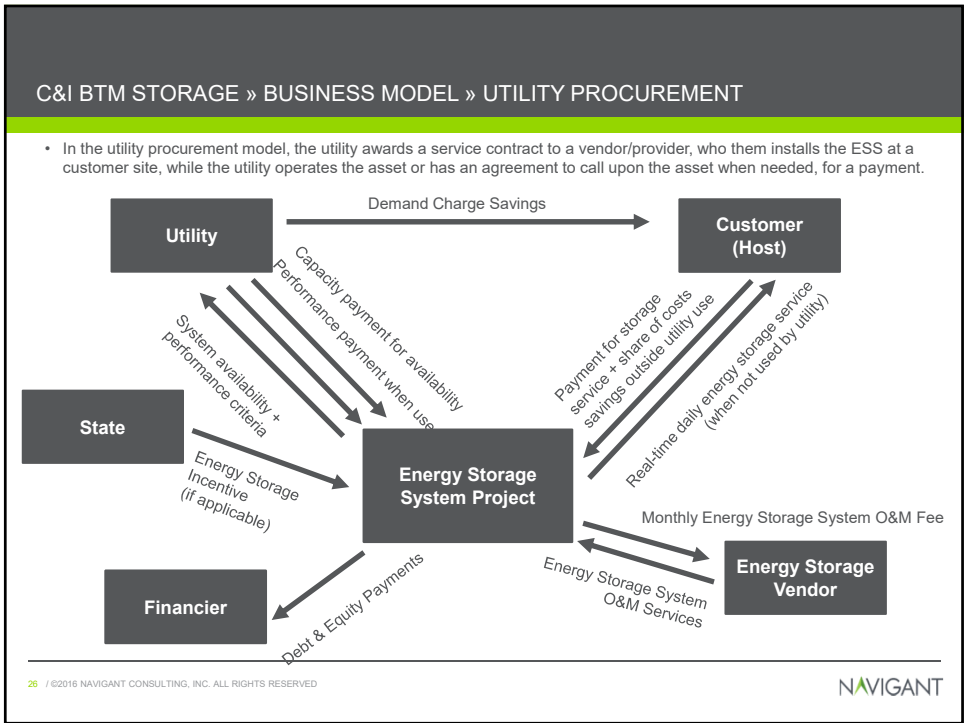
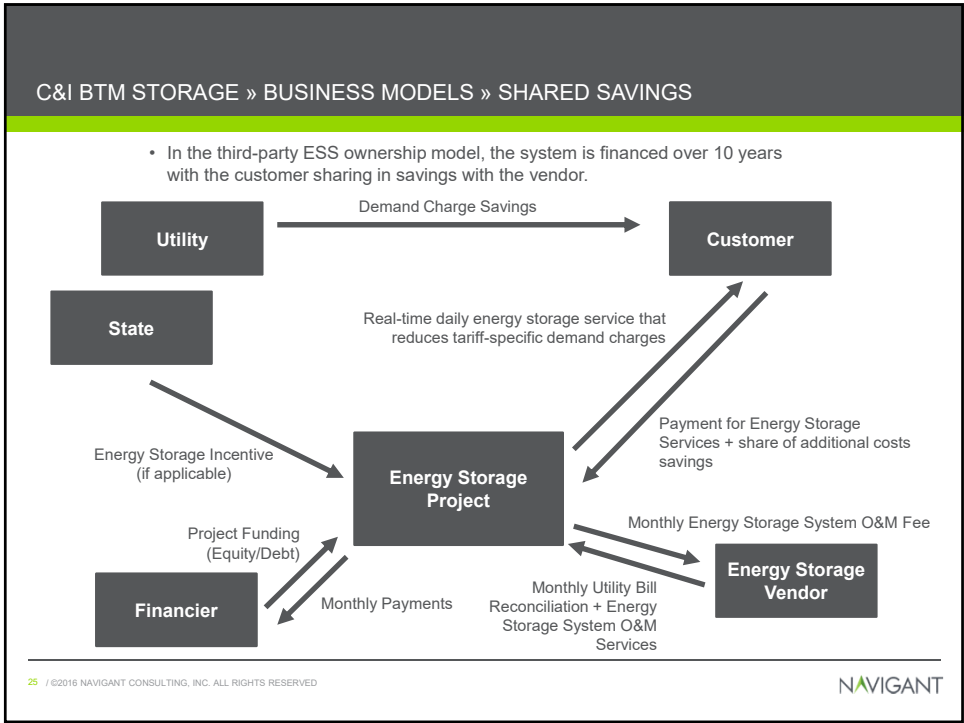
Metric	Current Status
Energy Density	80-200 Wh/kg
Max. Discharge Time	4-12 hrs
Cycle Life	300-25,000 cycles
Calendar Life	4-7 years
Round Trip Efficiency	90-95%
2016 Price	\$240-\$2,200/kWh
Advantages	High power and energy densities, scalable
Disadvantages	Potential thermal runaway
Manufacturers	Panasonic, LG Chem, Samsung SDI

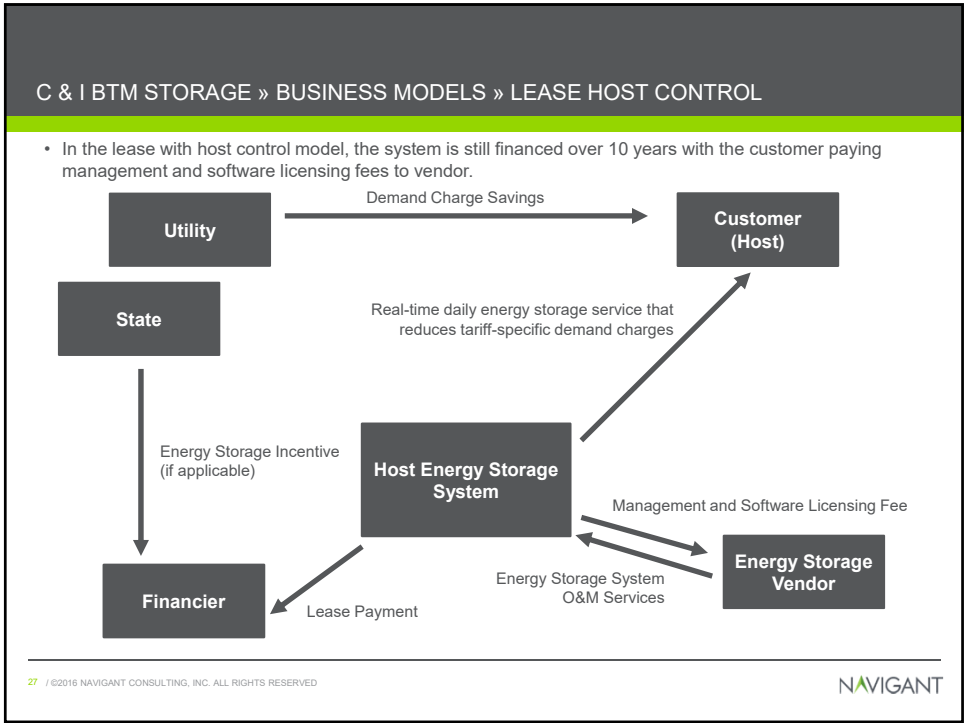
**Flow Batteries**

- Iron chromium systems are able to operate at a range of voltages and currents, which allows more flexibility in terms of controls.
- Main issues include development of robust electrolyte membranes, balance of system costs, and a limited vendor landscape

Metric	Current Status
Energy Density	15-85 Wh/kg
Max. Discharge Time	3-12 hrs
Cycle Life	3,000-5,000 cycles
Calendar Life	8-15 years
Round Trip Efficiency	65-80%
2014 Price	\$500-\$1,200/kWh
Advantages	Long life, modularity, safe materials
Disadvantages	Balance of system costs
Manufacturers	Primus Power, UniEnergy, Imergy, Gildemeister

SUPPLEMENTAL SLIDES

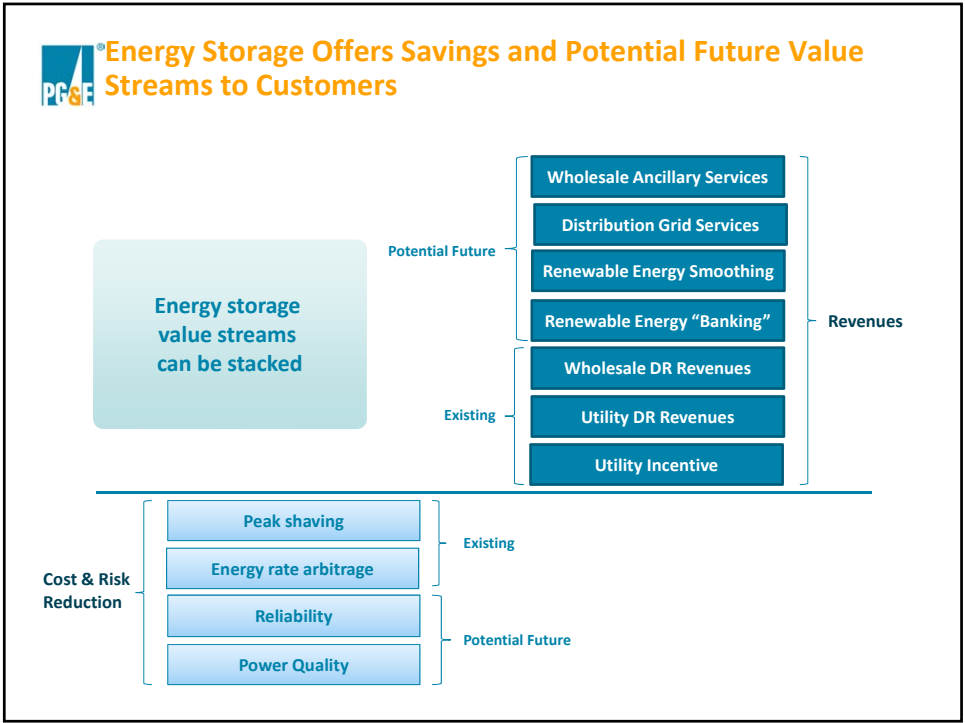
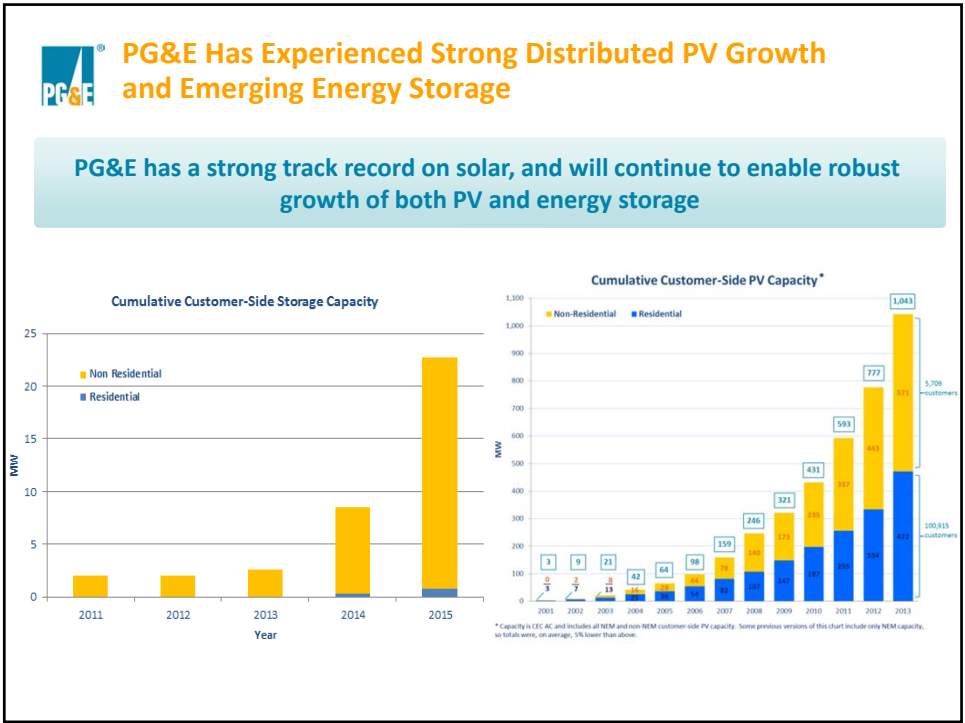




# Women in DR

May 2016

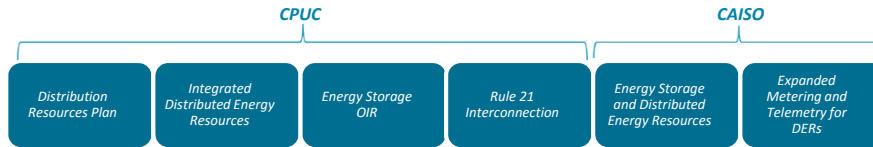
*Elise Hunter*  
Expert Analyst, Distributed Generation





## Policy Platforms – Emerging Role of Storage in CA

Policies are focusing on the role of storage at the grid edge:



### CAISO Initiatives: ESDER and EMTO-DERP

**Purpose: modifies wholesale markets for DERs and establishes rules for aggregators**

- EMTO-DERP establishes rules for operators of DER aggregations. Tariff filing at FERC March 2016.
- Most recent EMTO-DERP seeks to prohibit double compensation, following PG&E advice.
- ESDER Phase 2 opens wholesale markets beyond DR to BTM storage and other DERs beyond traditional demand response (e.g. energy consumption, exporting).
- In ESDER Phase 2, CAISO pledges to work more closely with CPUC to develop rules for BTM DERs participating in new wholesale markets.

### CPUC Energy Storage OIR Track 2

**Purpose: Establishes rules for storage in both FERC and CPUC jurisdictions**

- Parties asked to identify and prioritize Multiple Use Applications (MUA) for storage.
- PG&E Key Principles focus on cost recovery, interconnection safety and operational feasibility.
- MUA workshops kicked off in May 2016, will continue through the summer



## Key Questions for Emerging Role of Storage

- 1) How can both the value and cost of storage be correctly analyzed in these emerging roles?
- 2) How can different value streams be prioritized and valued?
  - Customer
  - Distribution and Transmission Grid
  - Market
- 3) How can storage help meet customer expectations with value-added products, programs and services?
- 4) How can risks be mitigated?
  - Grid safety and customer safety
  - Reliability concerns
  - Double compensation or shifted costs to non-participating ratepayers



In 2015, PLMA continued to deliver high quality benefits to our growing and increasingly diverse membership.



Through participation in our breadth of activities, our highly-engaged membership is helping PLMA fulfill its mission!

**2015 SAW A 20% INCREASE IN MEMBERSHIP AND AN IMPROVED MEMBER EXPERIENCE!**



Our growing and increasingly diverse membership base has led to broader, deeper and more nuanced content at conferences and in DR Dialogues, Member Meet-Ups and interest group meetings.

**PLMA OFFERED 34 MEMBER ACTIVITIES IN 2015**

with a total of **2,946 participants** and over **1,400 individual participants** - an **86% increase** over 2014

**PLMA'S LEADING-EDGE PROFESSIONAL DEVELOPMENT ACTIVITIES**

Keep members on the forefront in an increasingly complex DR market.

**The Spring and Fall Conferences** drew **308 total attendees** and featured spirited discussion of critical topics in the industry as well as **networking opportunities** for members and attendees.


The new **3 part Demand Response training series**, launched in 2015, drew **high satisfaction scores** from attendees. The **Demand Response** training courses provided an intensive education experience to more than **130 industry professionals**.

**DR Dialogue webcasts** are the most popular member benefit. 13 DR Dialogues drew **1,567 total registrations**.

**Interest-group webinars** drew **680 registrants**.

**2,946**

TOTAL REGISTRATIONS



**4 INTEREST GROUPS** provided in-person and online opportunities for members to discuss industry best practices and exchange practitioner tips—plus, 8 new groups. Distributed Energy Resources Integration was added in 2015.

**PLMA COLLABORATED** with the National Rural Electric Cooperative Association (NRECA) and the National Resources Defense Council (NRDC) to successfully advocate on behalf of our members and the industry for a continued role in grid-interactive water heating as a DR resource.

**NETWORKING OPPORTUNITIES ABOUND**

Members build or renew personal ties in an informal setting at the many Meet-Ups held, plus opportunities at conferences and during interest group meetings.

In 2015, PLMA continued to operate as a platform to disseminate information on **technological advances, policy changes, regulatory actions, and operational insights** across our member base.