

State & Federal
Energy Storage Technology
Advancement Partnership
(ESTAP) Webinar:

**Resilient Solar-Storage Systems
for Homes and Commercial
Facilities**

July 17, 2013



Housekeeping

- All participants will be in listen-only mode throughout the broadcast.
- It is recommended that you connect to the audio portion of the webinar using VOIP and your computer's speakers or USB-type headset. You can also connect by telephone. If by phone, please expand the Audio section of the webinar console to select "Telephone" to find the PIN number shown and enter it onto your telephone keypad.
- You can enter questions for today's event by typing them into the "Question Box" on the webinar console. We will pose your questions, as time allows, following the presentation.
- This webinar is being recorded and will be made available after the event on the CESA website at

www.cleanenergystates.org/events/

State & Federal Energy Storage Technology Advancement Partnership (ESTAP)

Todd Olinsky-Paul
Clean Energy States Alliance



Thank You:

Dr. Imre Gyuk

U.S. Department of Energy,
Office of Electricity Delivery and
Energy Reliability

Dan Borneo

Sandia National Laboratories



ESTAP is a project of CESA

Clean Energy States Alliance (CESA) is a non-profit organization providing a forum for states to work together to implement effective clean energy policies & programs:

- Information Exchange
- Partnership Development
- Joint Projects (National RPS Collaborative, Interstate Turbine Advisory Council)
- Clean Energy Program Design & Evaluations
- Analysis and Reports

CESA is supported by a coalition of states and public utilities representing the leading U.S. public clean energy programs.



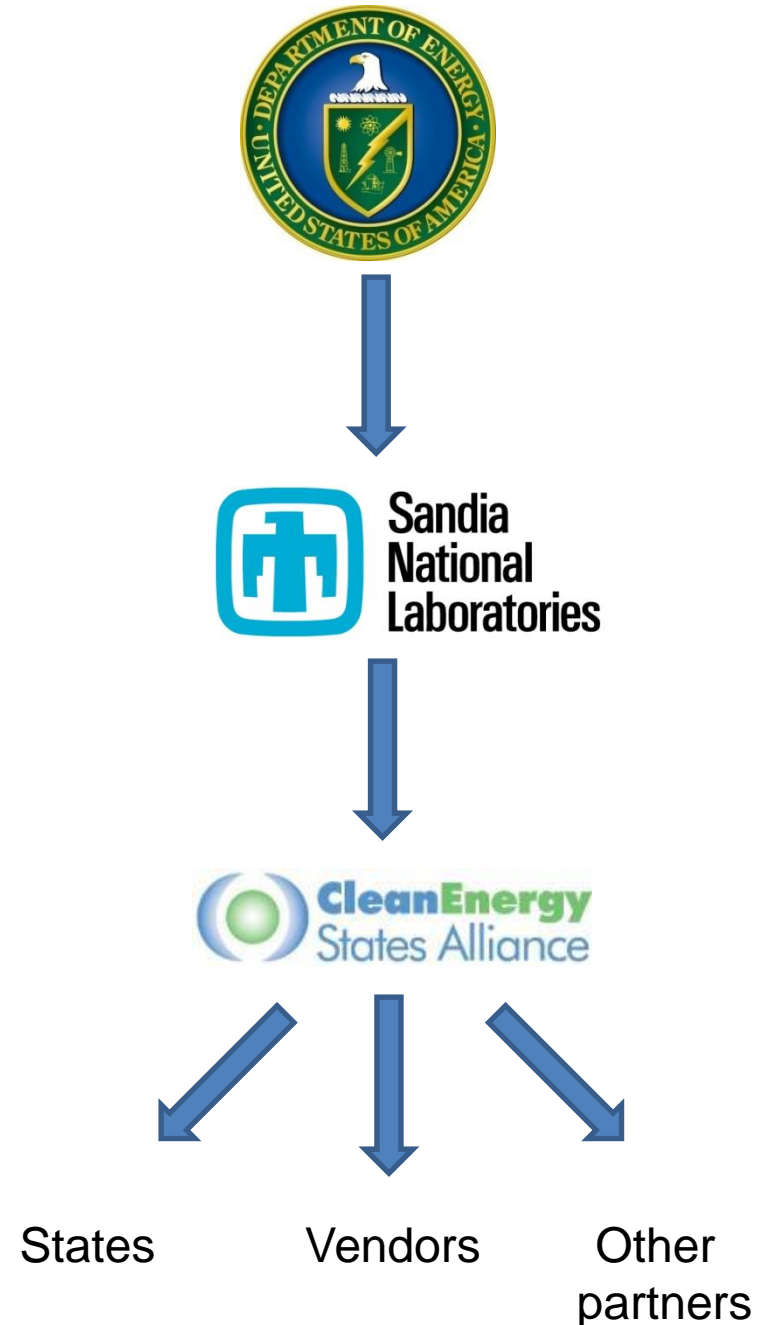
ESTAP* Overview

Purpose: Create new DOE-state energy storage partnerships and advance energy storage, with technical assistance from Sandia National Laboratories

Focus: Distributed electrical energy storage technologies

Outcome: Near-term and ongoing project deployments across the U.S. with co-funding from states, project partners, and DOE

* (Energy Storage Technology Advancement Partnership)



ESTAP Key Activities

1. Disseminate information to stakeholders

- ESTAP listserv >500 members
- Webinars, conferences, information updates, surveys

2. Facilitate public/private partnerships at state level to support energy storage demonstration project development

- Match bench-tested energy storage technologies with state hosts for demonstration project deployment
- DOE/Sandia provide \$ for generic engineering, monitoring and assessment
- Cost share \$ from states, utilities, foundations, other stakeholders



ESTAP Webinars

<http://bit.ly/12KJTUQ>

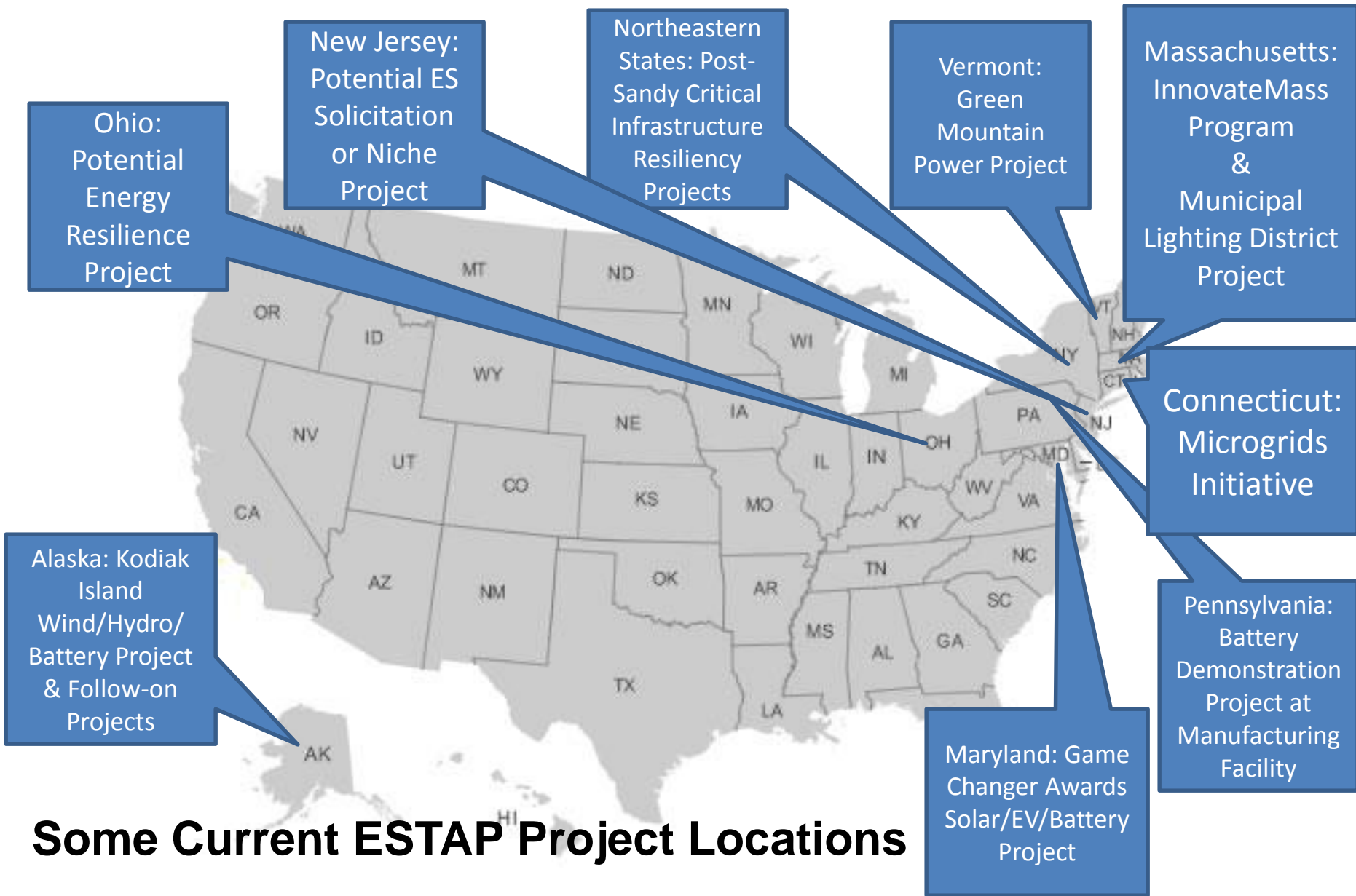
Policy Webinars:

- Introduction to the Energy Storage Guidebook for State Utility Regulators
- Briefing on Sandia's Maui Energy Storage Study
- The Business Case for Fuel Cells 2012
- State Electricity Storage Policies
- Highlights of the DOE/EPRI 2013 Electricity Storage Handbook in Collaboration with NRECA – June 18

Technology Webinars:

- Smart Grid, Grid Integration, Storage and Renewable Energy
- East Penn and Ecoult Battery Installation Case Study
- Energy Storage Solutions for Microgrids
- Applications for Redox Flow Batteries
- Introduction to Fuel Cell Applications for Microgrids and Critical Facilities
- UCSD microgrid





Some Current ESTAP Project Locations

Today's Speakers

Dr. Imre Gyuk, U.S. Department of Energy,
Office of Electricity Delivery and Energy Reliability

Michael Kleinberg, DNV KEMA Energy & Sustainability



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<http://www.cleanenergystates.org/projects/energy-storage-technology-advancement-partnership/>

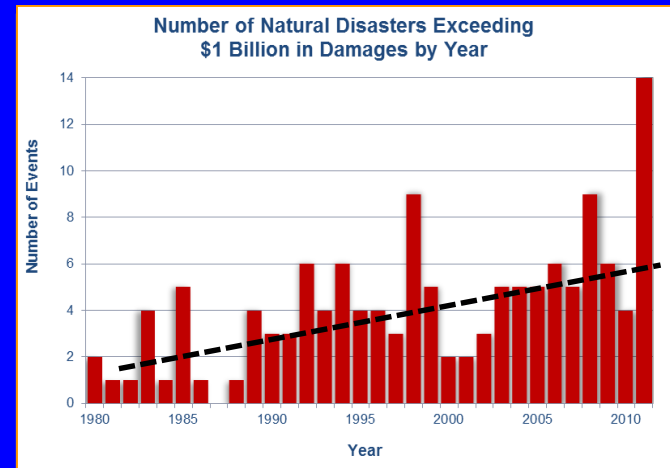
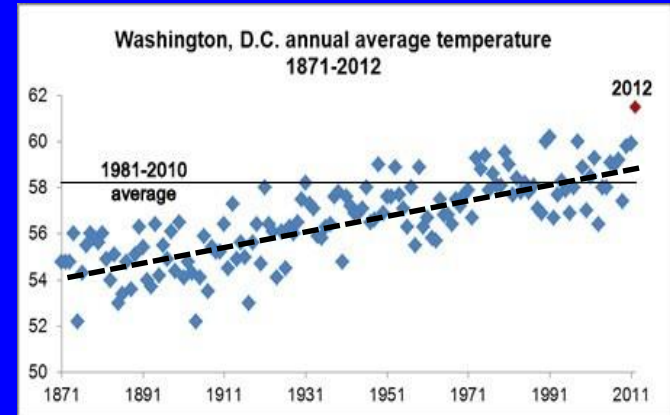


Energy Storage for Grid Resilience

IMRE GYUK, PROGRAM MANAGER
ENERGY STORAGE RESEARCH, DOE

Energy Storage for Emergency Preparedness

Every \$1 on protection measurements
Can prevent \$4 in repairs after a storm!



Trends indicate the situation
will get worse not better!!

Some 50% of Diesel Generators failed to start during the Sandy Emergency

Storage allows Microgrids to provide essential Services over an extended Time Period

During non-emergency Periods Storage can provide Demand Management for the User and compensated Services to the Grid

Apartment Buildings – Campuses – Schools – Shopping Centers – Community Centers – Nursing Homes – Hospitals – Police Stations – Gas Stations – etc. etc

Connecticut DEEP

(Dept. of En. & Env. Protection)

a DOE/CESA/ESTAP Project

\$15 M solicitation to develop microgrids for emergency preparedness throughout Connecticut and increase local resiliency and reliability in the event of natural disasters

Sandia/DOE reviewed Preliminary micro grid Project Proposals, suggesting where storage could be added and providing input for projects that already include storage

Sandia/DOE will monitor all energy storage Projects for DEEP to insure that systems are viable and operate as the awardees proposed. We may provide help and funding to insure successful implementation of the ES.



Primus Power / Raytheon

Marine Corps Air Station

Miramar, CA

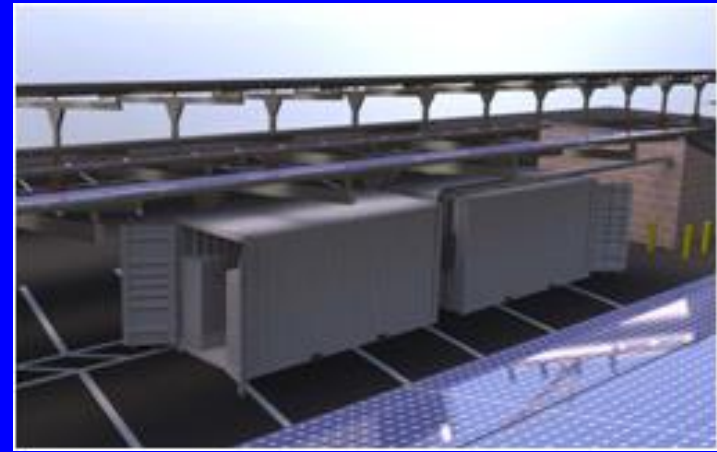
An ESTCP Project

250kW- 4hr EnergyPod™ (ZnBr) for 230kW PV with micro-grid capability. Completion 2014

Mission critical backup power
Islanding and Peak Shaving capability

Miramar lost power in September 2011 Great Southwest Blackout

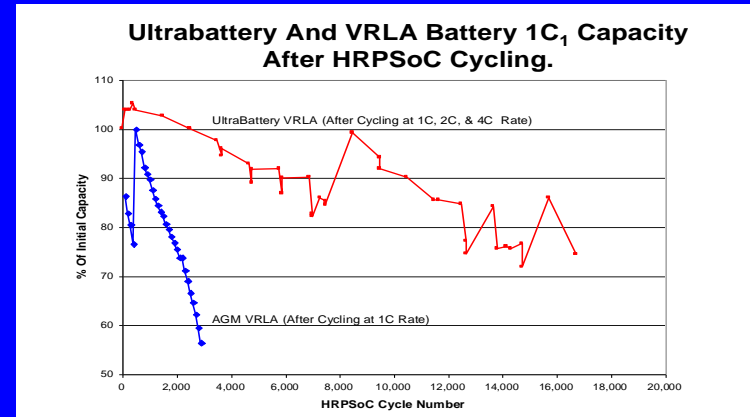
- Training missions cancelled
- Planes grounded
- 25% of diesel generators had trouble starting



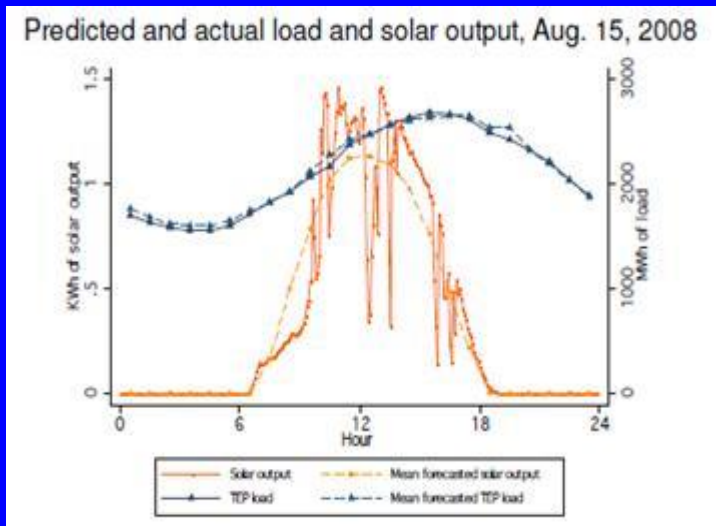
Battery system developed under ARRA

Medium Size Projects: 1-5 MW

ARRA – Public Service NM:
500kW, 2.5MWh for smoothing of
500kW PV installation; Using
EastPenn Lead-Carbon Technology



PbC Testing at Sandia



Load & PV Output in Tucson, AZ



Commissioned Sep. 24, 2011 Integrator: Ecoult

Reading Massachusetts

Reading Municipal Light and Power Station a DOE/CESA/ESTAP Project

Preform feasibility study to utilize ES to reduce peak demand in a cost effective manner. Develop ES specifications. Monitoring and performance analysis

DOE/Sandia helped defined scope of project. Introduced Aquion Energy Aqueous Na-ion Battery. System

Project will reduce peak demand by load shifting. To be funded by municipal bond and optional DOE funding.



Built 1894 – Nat. Register of Hist. Places

SNL Energy Storage System Analysis Laboratory

Reliable, independent, third party testing and verification of advanced energy technologies from cell to MW scale systems



Redflow at DETL



Energy Storage Test Pad (ESTP)



Milspray Deka Battery under testing

System Testing

- Scalable from 5 KW to 1 MW, 480 VAC, 3 phase
- 1 MW/1 MVAR load bank for either parallel microgrid, or series UPS operations
- Subcycle metering in feeder breakers for system identification and transient analysis
- Can test for both power and energy use
- **Safety Analysis**

Energy Storage provides Resiliency to the Grid!

*renewable integration – rooftop PV – military micro grids – VARs
emergency preparedness – island grids – EV charging – G2V –
dispatchable solar farms - frequency regulation - etc. etc.*

We need it everywhere!



Solar-Storage Systems

Residential resiliency - DRAFT NYSERDA Report
Commercial cost-effectiveness – DRAFT CPUC Report

DNV KEMA
July 17th, 2013



Contents

1	Introduction
2	Residential Critical Load Analysis and Storage Requirements
3	Incremental Cost of Residential Energy Storage
4	Existing Solutions
5	C&I Applications
6	Demand Side Storage - Commercial Cost-Effectiveness

Motivations - Residential

- Recent natural disasters have exposed “gaps” in grid reliability
- Increased focus on utilization of distributed generation assets, notably PV, to address these gaps
- An area of particular interest is allowing distributed generation assets to “island” from the grid during an outage

After the storm, the long wait for power

It took utilities in New York and New Jersey nearly two weeks to restore power to 95 percent of customers who lost it after Superstorm Sandy. That’s among the longest outages since 2004, but restoration was slower after several other storms.

Duration of power outages caused by major hurricanes and tropical storms

YEAR	STORM	STATE	DAYS TO RESTORE POWER TO 95% OF THOSE WHO LOST IT	PEAK OUTAGES IN MILLIONS (AND % OF CUSTOMERS)
2005	Katrina	Louisiana	23+*	0.91 (42%)
2005	Rita	Texas	16	0.78 (8%)
2005	Katrina	Mississippi	15	1.00 (70%)
2005	Wilma	Florida	14	3.25 (36%)
2008	Ike	Texas	14	2.47 (23%)
2012	Sandy	New York	13	2.10 (23%)
2012	Sandy	New Jersey	11	2.62 (65%)
2004	Ivan	Florida	10	0.44 (5%)
2012	Sandy	West Virginia	10	0.27 (27%)
2004	Charley	Florida	9	1.60 (18%)
2004	Frances	Florida	8	3.50 (40%)
2004	Ivan	Alabama	8	1.07 (46%)
2011	Irene	New York	7**	0.94 (12%)
2012	Sandy	Pennsylvania	6**	1.27 (20%)
2011	Irene	New Jersey	6**	0.81 (18%)
2012	Sandy	Connecticut	6**	0.63 (31%)

* Louisiana had restored power to 75 percent of customers after Katrina when Hurricane Rita arrived and knocked out more customers.

** Selected recent outages of less than eight days listed for comparison.

SOURCES: U.S. Department of Energy; Ventyx; AP analysis

AP

DNV KEMA Cost Effectiveness Evaluation for CPUC

■ Study Scope

- Develop methodologies to evaluate storage's cost-effectiveness
 - **Goal is to reach consensus on tools used to evaluate storage**
- Perform example cost-effectiveness evaluations on a subset of the priority Use Cases identified in Phase 1 of the ES OIR

■ Selected Use Cases Examined

- **Transmission Connected Energy Storage**
 - Ancillary Services Storage, Frequency Regulation Only
 - Comparative Portfolio of Storage Resource Additions (for evaluating system level impacts)
- **Distribution Level Energy Storage**
 - Substation sited storage, for substation capacity upgrade deferral
 - Distribution circuit sited storage, for photovoltaic (PV) related circuit upgrade avoidance and load growth related substation capacity deferral

- **Demand Side (Customer Side) Energy Storage**
 - Customer Bill Reduction

Contents

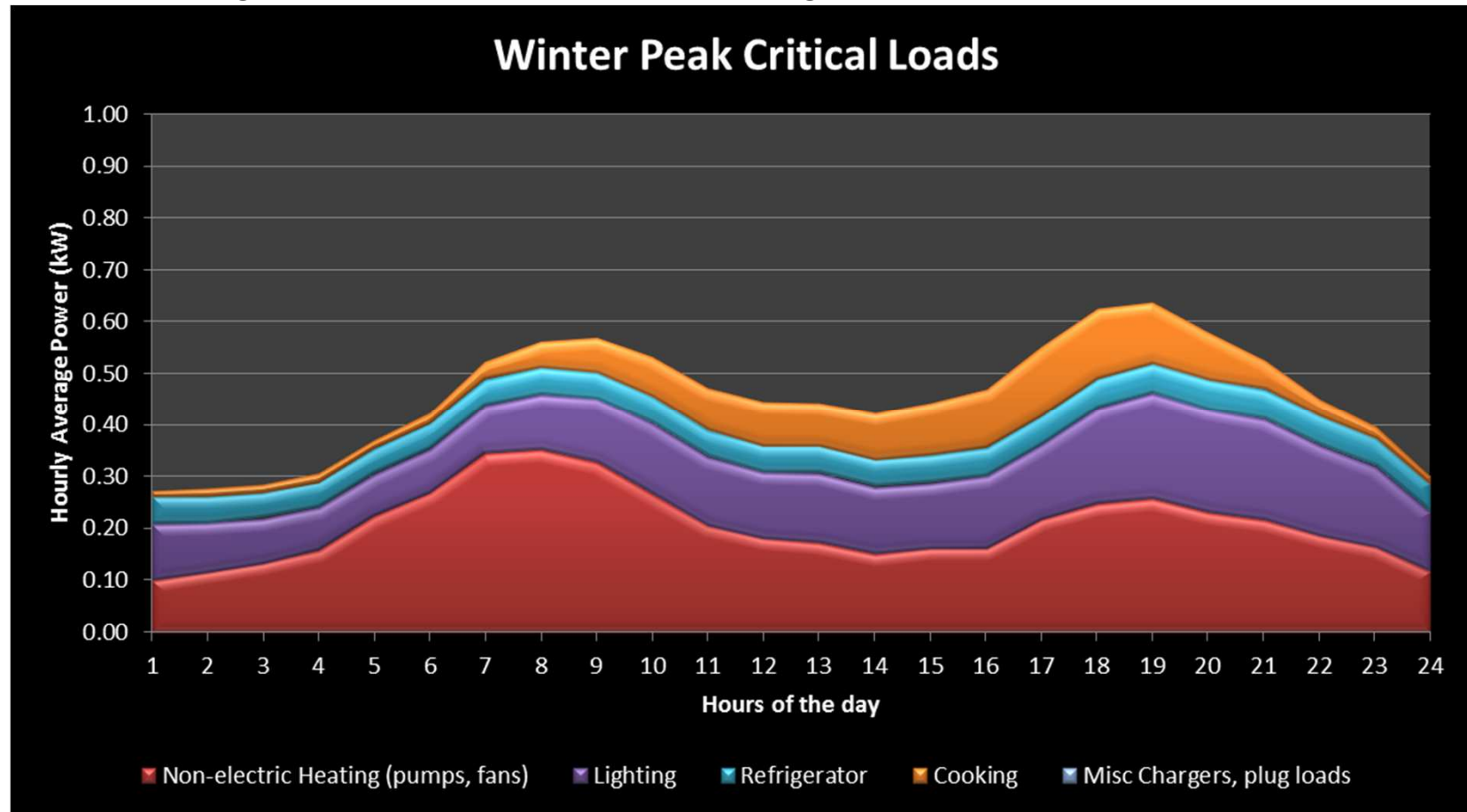
- 1 Introduction
- 2 Residential Critical Load Analysis and Storage Requirements
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- 4 Existing Solutions
- 5 C&I Applications
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Critical Loads

- It is not practical to design backup systems to support all electrical loads in a typical residence
- Customers and installers need to agree on which loads and circuits require backup during an outage
 - Capacity of the backup system is based on the power and energy requirements of the critical loads
 - Expected demand serves as baseline to specify inverter and battery-capacity requirements
- The analysis here draws from Northeast residential load shapes for: heating, cooling, refrigeration, cooking, water heating, and misc. chargers and plug loads
- The data draws from the DNV KEMA load profile data base for New York:
 - Electric Water Heater – DNV KEMA study for Northeast Energy Efficiency Partnership (NEEP)
 - Central A/C – DNV KEMA source
 - Electric Heating – DNV KEMA study for NEEP
 - Non-electric Heating (pumps, fans) – DNV KEMA study for NEEP
 - Lighting – DNV KEMA study for NEEP
 - Refrigerator – Northwest Regional Technical Forum Data
 - Cooking – Northwest Regional Technical Forum Data
 - Misc Chargers, plug loads – DNV KEMA source

Winter Peak Residential Critical Load

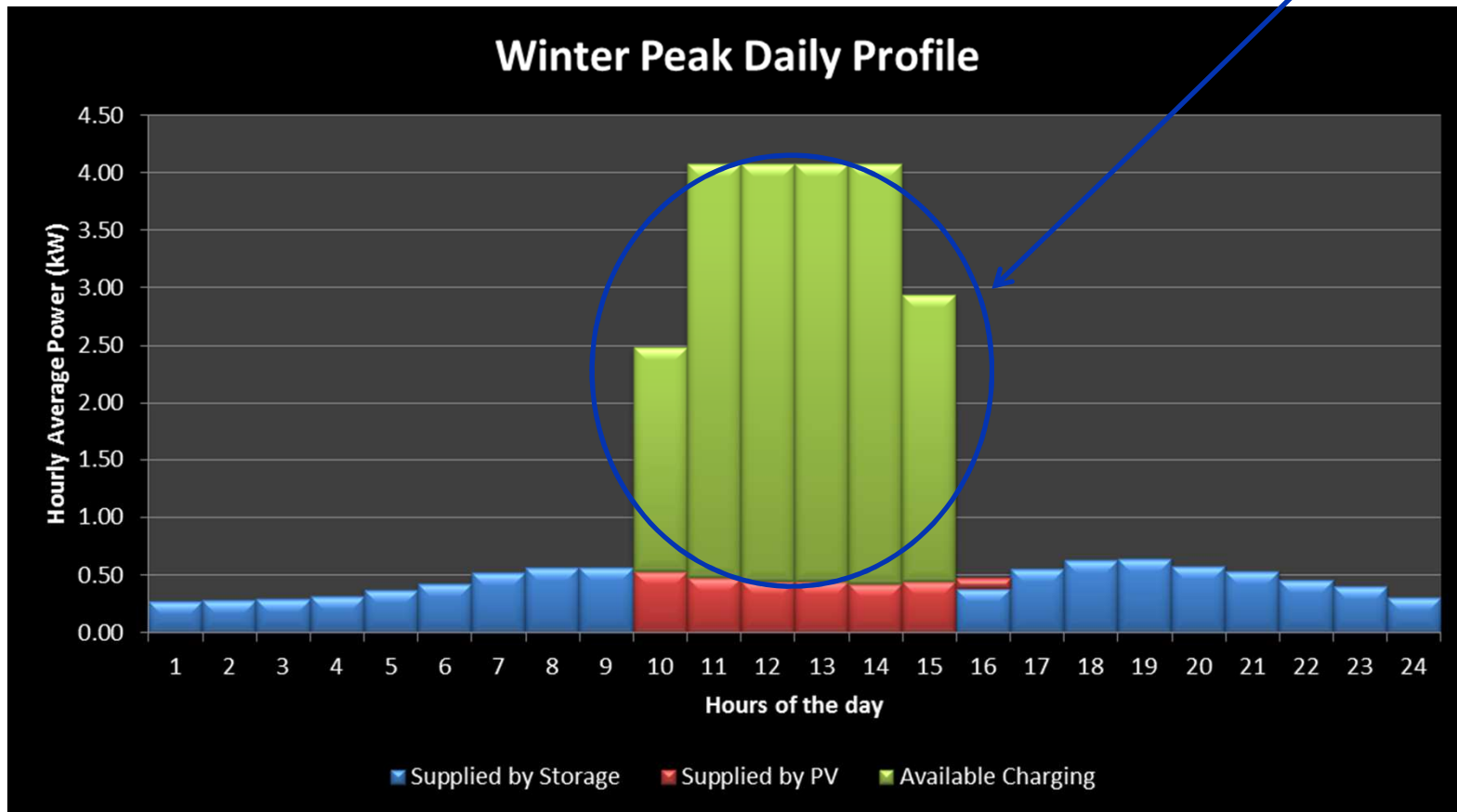
- Graph shows hourly critical kW demand / kWh energy for a peak Winter day
- Electric heating and electric hot water heating not included



Winter Excess Generation

- Typical NY State Winter PV profile matched to critical load profile
- Assumes 5 kW PV installation

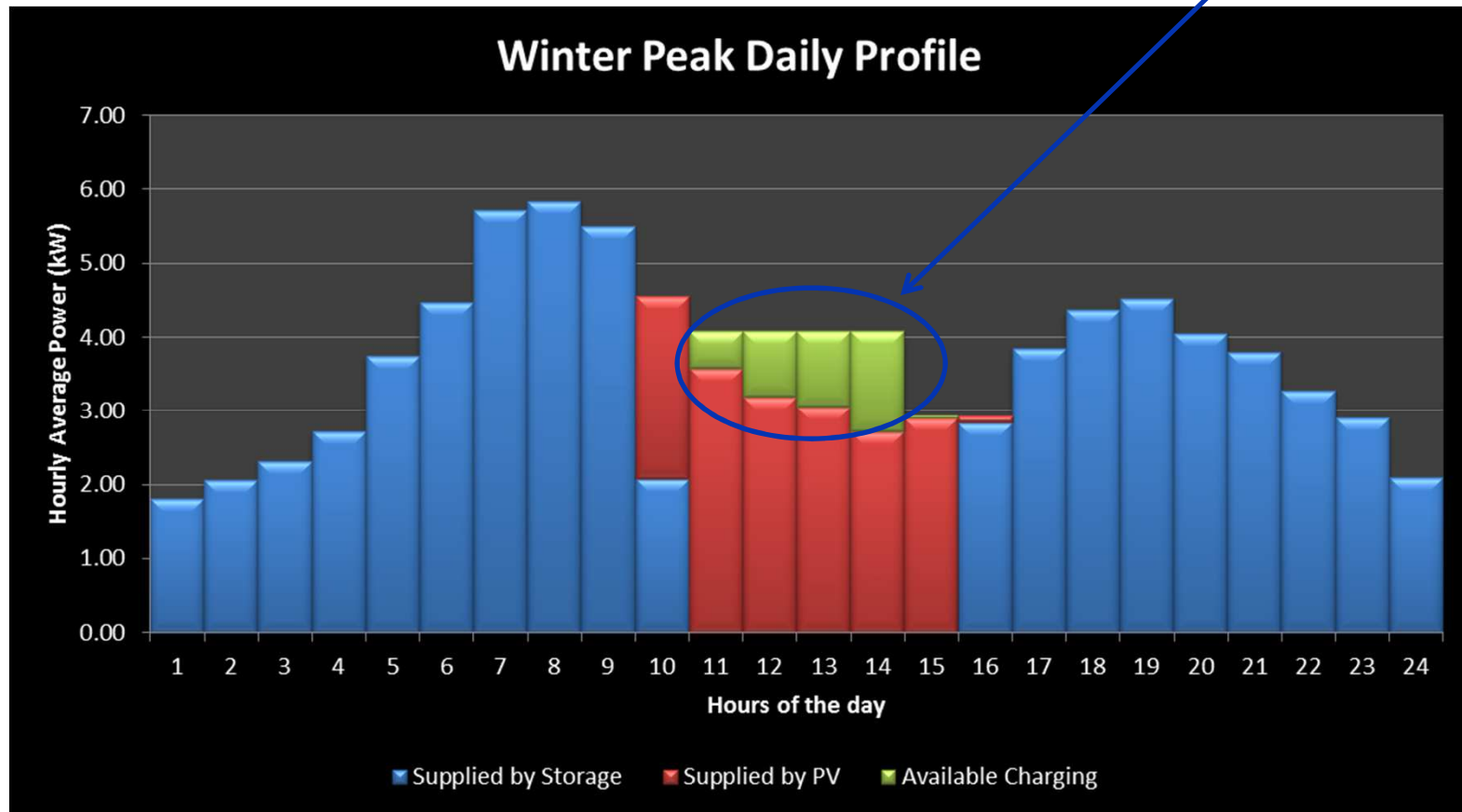
Excess PV to charge storage



Winter Peak with Electric Heating

- Backup solar-storage system cannot support whole home electric heating load during an extended outage

Insufficient excess for charging



Storage Requirements and Recommendations

Sizing Recommendations

- DNV KEMA recommends sizing storage and interconnection components at a minimum of 5kW for residential backup in New York
- DNV KEMA recommends a minimum of 10 kW-hrs for residential back-up in New York
 - alternative to larger storage capacity is a reduction in critical load usage during the outage
 - Infeasible to supply central A/C or electric heating

Balance of Plant and Control Recommendations

- DNV KEMA recommends solar-storage backup systems provide a means to monitor storage state-of-charge during backup operation
- Advanced functionality such as automated and/or remote control of critical loads, through the system gateway or home EMS controller, can further improve survivability

Contents

- 1 Introduction
- 2 Residential Critical Load Analysis and Storage Requirements
- 3 Incremental Cost of Residential Energy Storage
- 4 Existing Solutions
- 5 C&I Applications
- 6 Demand Side Storage - Commercial Cost-Effectiveness

Case Study: California

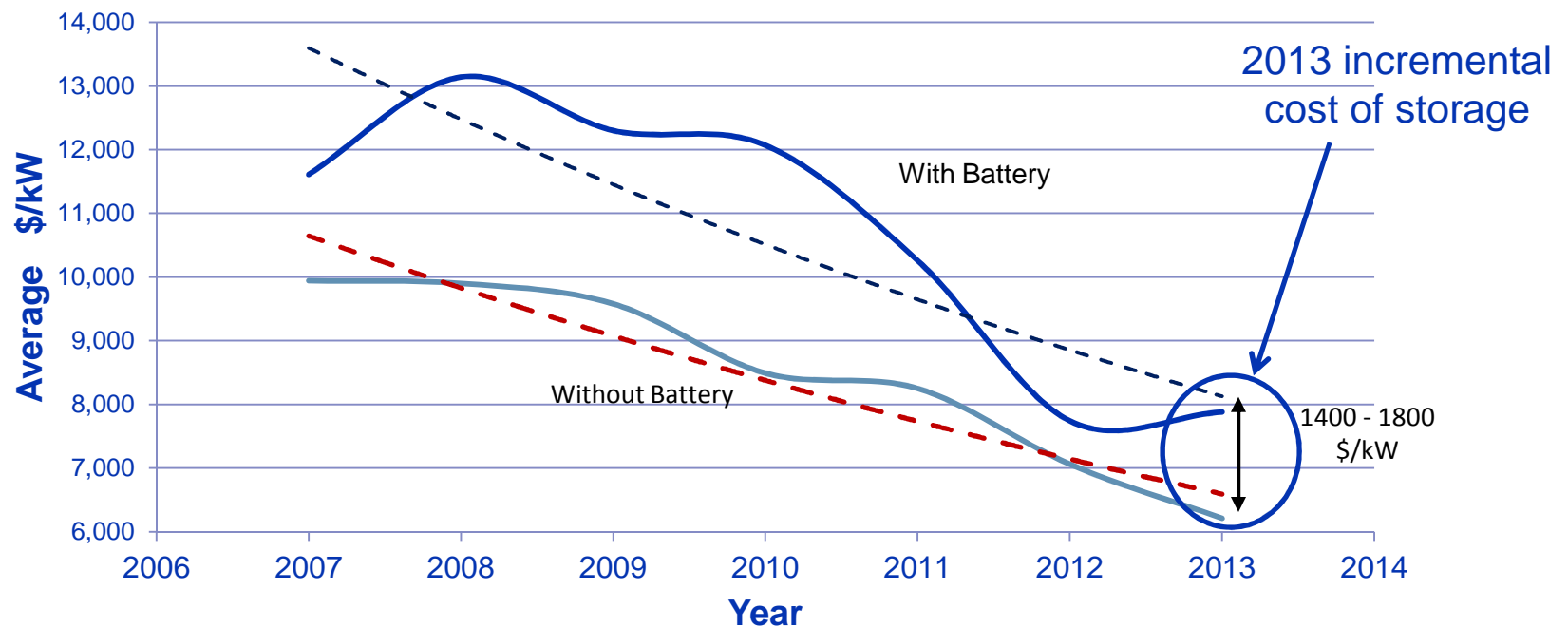
- Comparison of the “installed cost” of PV systems in California with and without energy storage over the last seven years.
- PV installations w/ battery averages 0.4% of total PV installations in California

Year completed	Res PV with batteries		Res PV (no battery) systems	
	# of systems	\$/Watt	# of systems	\$/Watt
2007	11	\$ 11.61	3,420	\$ 9.94
2008	52	\$ 13.14	7,613	\$ 9.90
2009	75	\$ 12.30	12,628	\$ 9.58
2010	38	\$ 12.07	16,058	\$ 8.49
2011	38	\$ 10.26	21,411	\$ 8.25
2012	29	\$ 7.74	28,301	\$ 7.06
2013	10	\$ 7.88	4,729	\$ 6.21

Case Study: California

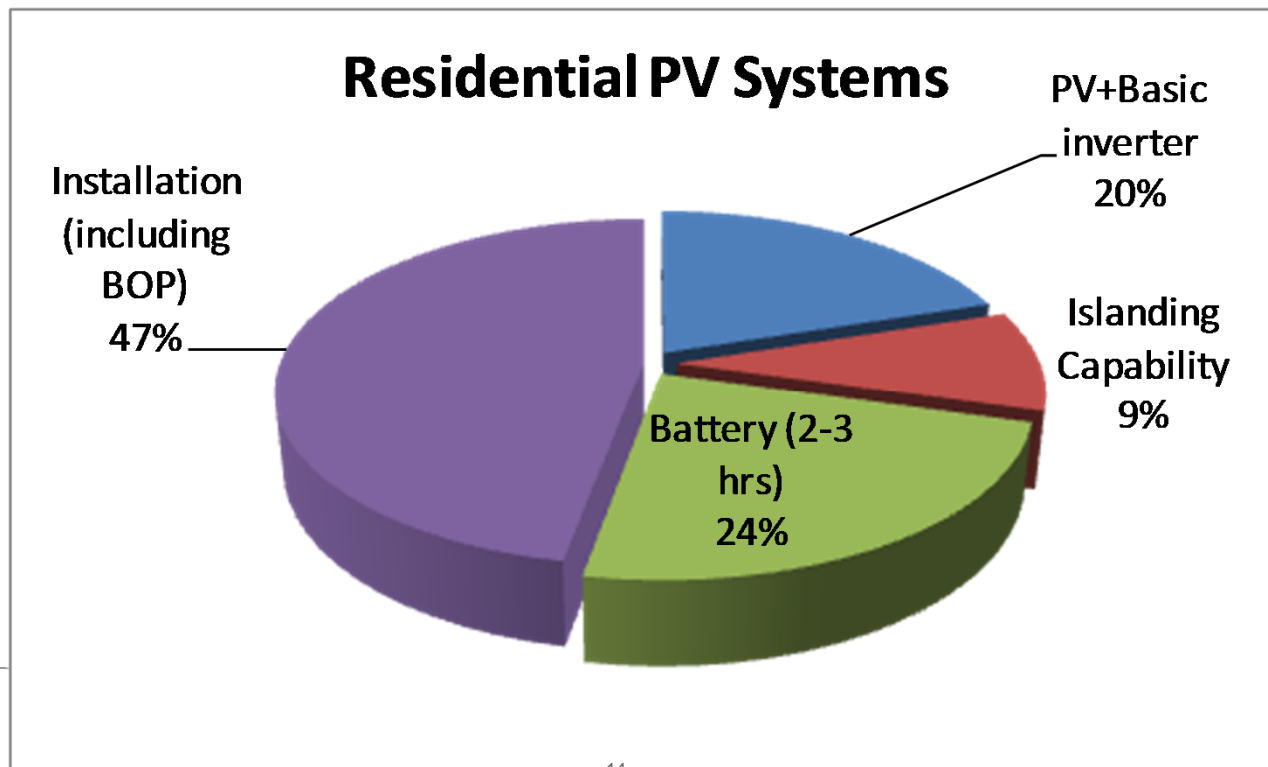
- Cost of installed PV in CA, with and without a battery, has been declining over the last several years at an average rate of 7% per year
- Incremental cost for adding storage to PV has been declining at average rate of 11% per year
- Detailed data for each installation unavailable, but belief is these system include supplying critical load

Cost of Installed Residential PV in California



Breakdown of Costs

- Depending on the type and size of PV, inverter, and batteries, the cost components vary but, on average, they may be generalized as follows:
 - Installation is about ½ the cost of an installed PV+ES system
 - Adding battery could double the PV hardware cost but its impact on the total installed cost is about 25 - 30%, depending on its capacity and capabilities.
 - Adding islanding capability to help PV system serve as a backup power could increase the installed cost by about 10%



Contents

- 1 Introduction
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- 3 Incremental Cost of Residential Energy Storage
- 4 Existing Solutions
- 5 C&I Applications
- 6 Demand Side Storage - Commercial Cost-Effectiveness

Existing Solutions

- Component Vendors

- SMA America <http://www.sma-america.com>
- Magnum Energy <http://www.magnumenergy.com>
- OutBack Power Technologies <http://www.outbackpower.com>
- Schneider Electric <http://www.schneider-electric.com>
- RedFlow Battery <http://www.redflow.com>

- Integrators (packaged solutions)

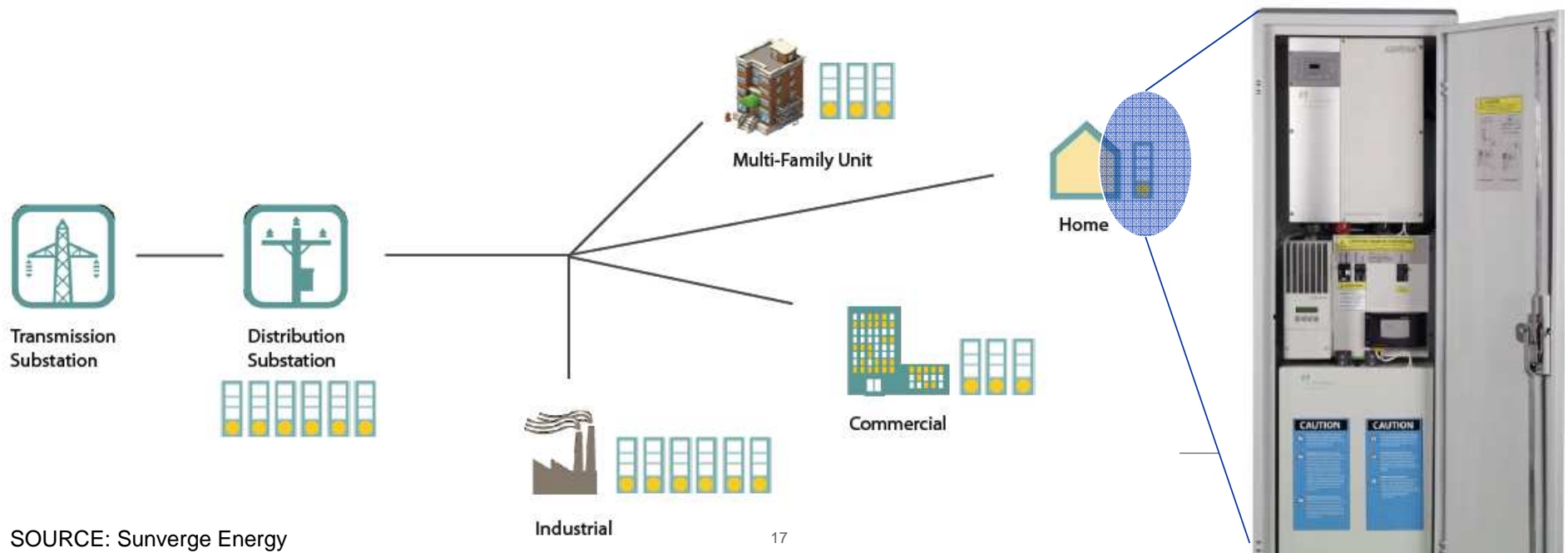
- Sunverge <http://www.sunverge.com>
- SolarCity <http://www.solarcity.com>

- Demo projects

- EcoCutie (Japan)

Sunverge Energy

- Sunverge solar integration system (SIS) consists of a 6 kW Schneider hybrid inverter and 10.77 kWh Li-Ion storage (capacity available up to 15.1 kWh)
 - unit is self-contained and sits behind the meter, NEMA 3 enclosure for indoor or outdoor installation
- Gateway used by the consumer to select loads that will operate in back-up mode
- Inclusion of storage allows for participation in utility demand response programs, even when not convenient for consumers



SOURCE: Sunverge Energy

Sunverge Energy

- Currently 38 installations on-line, with 184 planned by June, and 400 by end of 2013



Hybrid Inverter
Scaleable to 6 kW

Balance of System
Application Gateway

Lithium-ion Battery
Scaleable to 10.77 kWh

Patent Pending Enclosure



- Software application for remote monitoring of resources and storage state-of-charge

SolarCity

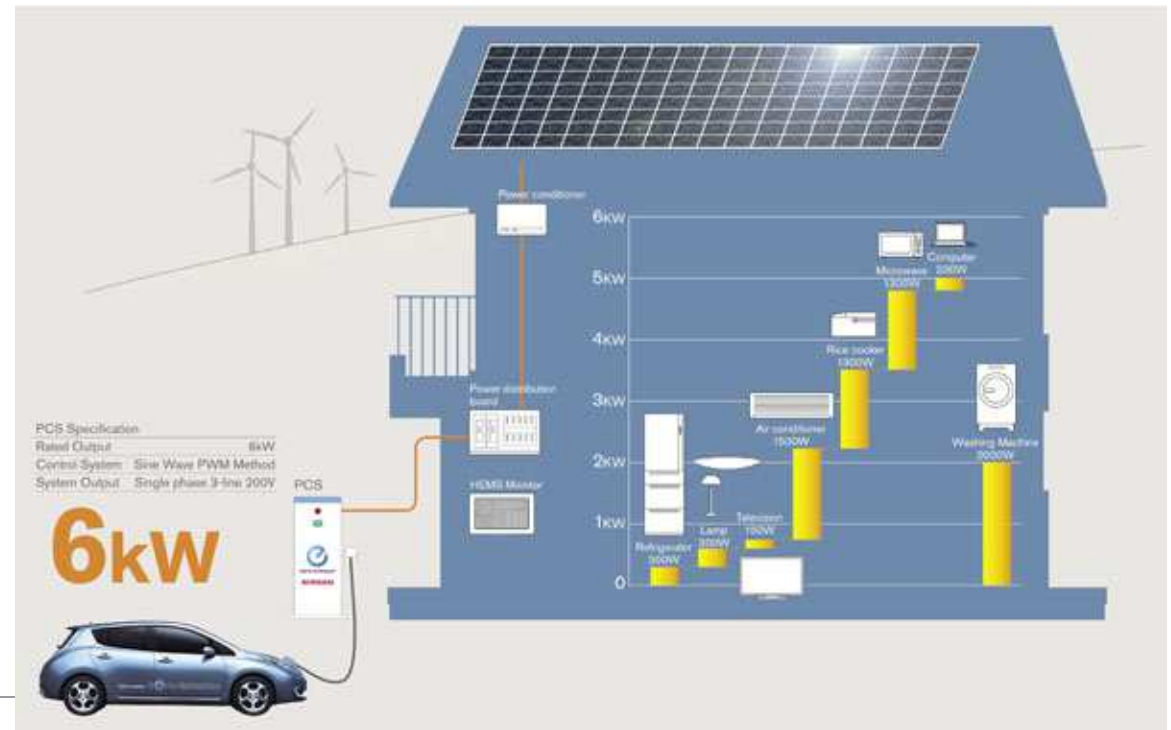
- Developed a wall mounted residential storage product, selling residential product today
 - 5 kW, 10 kWh, primarily Li-Ion with some advanced lead acid installations
- Interconnection built around SMA Sunny Island platform
- Primarily selling in CA because of SGIP funding for energy storage
 - SGIP rebate has made system installation cost-effective
 - System operates in parallel with the grid but also provides battery back-up,
 - Where allowed by tariffs, the system can perform market participation
- Over 70 SGIP applications for storage installations in 2012
- Solar lease program has signed on 21,000 customers in 2012
- Have not focused on Eastern US markets on residential, because lack of incentives



SOURCE: SolarCity

EV Based Home Backup

- "LEAF to Home" power supply system
 - supply from batteries onboard Nissan LEAF electric vehicles (EV) to homes during an outage
 - used with the "EV Power Station" unit developed by Nichicon Corporation
- Industry first backup power supply system that can transmit the electricity stored in the large-capacity batteries of Nissan LEAFs to a residential home.
- Available in Japan in 2013
- 6 kW, 24 kWh backup power
- \$6000 system on top of the cost of the vehicle



SOURCE: Nissan

Contents

- 1 Introduction
- 2 Residential Critical Load Analysis and Storage Requirements
- 3 Incremental Cost of Residential Energy Storage
- 4 Existing Solutions
- 5 C&I Applications**
- 6 Demand Side Storage - Commercial Cost-Effectiveness

C/I Customer-Sited ES, for Electric Bill Demand Charge and VAR Charge Reduction

- Commercial and Industrial (C/I) rate class tariffs typically have additional electric bill charges that residential tariffs don't: Demand charges and Power Factor (PF) penalties
- Demand charges are typically calculated on the measured peak power consumption (kW) per meter period (15-30minutes) per billing period (month)

- Example from ConEd's general service tariff for large C/I:

Demand Delivery Charges, per kW of maximum demand

Charges applicable for the months of June, July, August, and September	<u>Low Tension Service</u>	<u>High Tension Service</u>
first 5 kW (or less)	\$135.85 per month	\$105.05 per month
next 95 kW	\$22.34 per kW	\$16.99 per kW
over 100 kW	\$22.07 per kW	\$16.72 per kW

- PF penalties apply when a customer's PF (a measure of relative VAR vs WATT components of customer demand) are outside of allowed limits.
- Example from ConEd's charges, if C/I customer's PF is out of limits (0.95)

(4) Charge per kVar

\$1.10 per kVar

applicable to Customers specified in paragraph (1)(a), (b), (c), or (d) above for billable reactive power demand. Billable reactive power demand, in kVar, shall be equal to the kVar at the time of the kW maximum demand (as defined in

Demand Charges, ConEd's 'Plan Language' Description

understanding demand billing

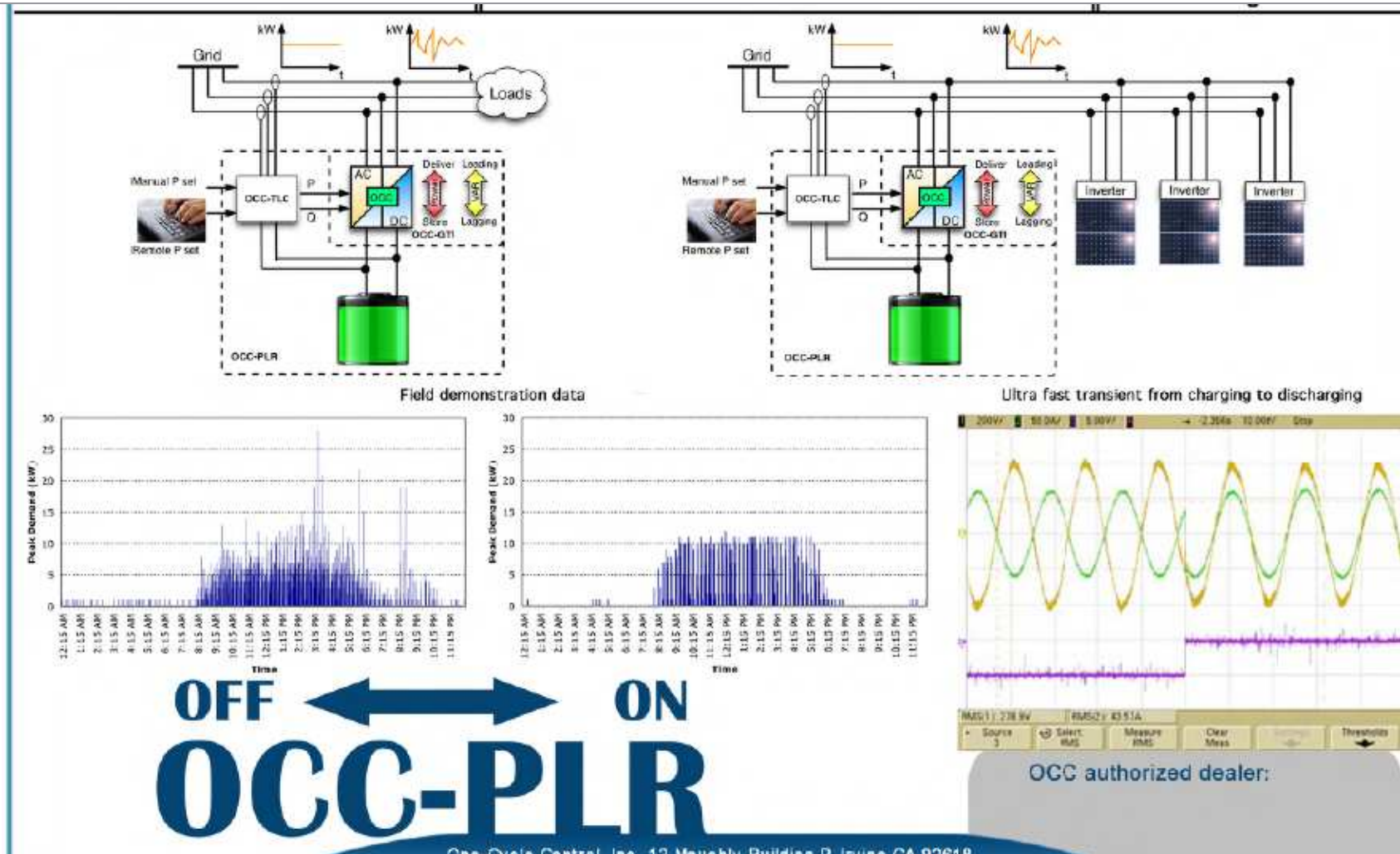
What Is Demand?

The term "demand" refers to the demand made by the customer upon the Company for the reserve of certain capacity. Whatever the energy requirements may be, we must maintain facilities with sufficient capacity to meet the maximum requirements of our customers. Even though these facilities may not always be used at full capacity, they are nonetheless required so that the electricity is available to customers whenever they want it. The demand charge reflects these capacity-related costs.

NOTE - The NYSERDA ES Incentive is designed to address the Demand (vs Energy) aspect of C/I customer load, "Performance-Based... Incentives are also provided for peak demand reductions associated with energy or thermal (ice) storage systems and high capacity, high efficiency electric chillers."

<http://www.nysERDA.ny.gov/Commercial-and-Industrial/CI-Programs/Existing-Facilities-Program/Performance-Based-Incentives/Electric-Efficiency-Incentives.aspx>

Example of ES Product for Demand Charge Reduction



Example of ES System for Demand Charge Reduction

Examples of potential customer bill-savings benefit, for a California GS C/I rate:

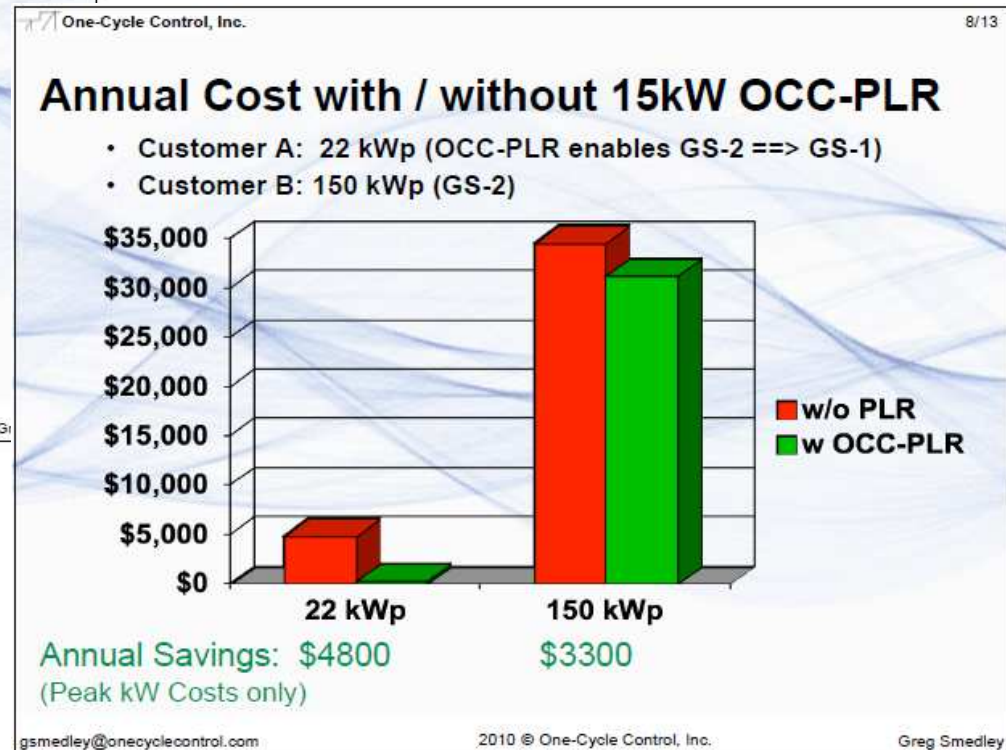
One-Cycle Control, Inc. 7/13

OCC-PLR Motivation

	< 20 kWp	20-200 kWp		
	GS-1	GS-2	GS-2 Option A	GS-2 Option B
Winter (\$/kWp)	-	\$12	\$12	\$12
Summer (\$/kWp)	-	\$31	\$12	\$29 (\$17 mid peak)

- SCE Rate Schedules & Peak Charges

gsmmedley@onecyclecontrol.com 2010 © One-Cycle Control, Inc. Gi



From OCC demo and presentation to the CA Energy Comm., March 2011

Example of ES System for Demand Charge Reduction

ARISTA PoD

Reduce electric utility demand charges with Arista's **Power on Demand** "Peak-Shaving" system.

WHAT IS PoD?

Arista's Power on Demand (PoD) solution is designed to reduce demand charges that can significantly increase utility bills for large users of electricity.

HOW DOES PoD WORK?

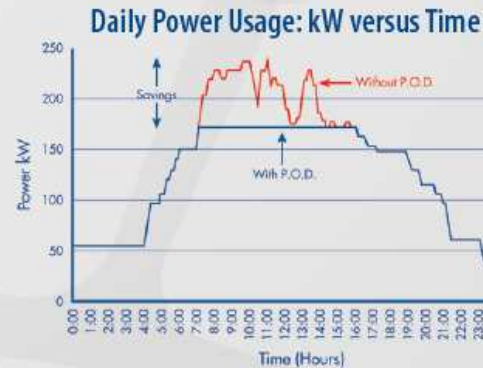
This innovative, patent-pending system is designed to utilize energy generated by wind turbines and/or solar arrays and energy stored from the grid itself to reduce peak electricity demand at consumer levels.

WHY PoD?

Dramatically lower your utility bills and benefit from a Return on Investment (or payback period) that no stand-alone renewable energy system can match.

WHAT IS A DEMAND CHARGE?

Large users of electricity often bear disproportionately high energy costs because they not only pay for the energy they actually use, but they are also required to pay for the right to have energy capacity available to them (whether or not they are using that capacity) at all times. This is called a "demand charge."



The chart above represents a customer's peak usage day that was used to determine their "demand charge." Arista's PoD system stores the energy captured from the WindTamer turbine and then releases the power during peak demand hours. This results in lower demand charges and utility bills for the customer. Use of the PoD system resulted in the following savings:

	Before System	Power -on- Demand
Monthly Demand Charges	\$3,625	\$2,360
Monthly Total	\$5,967	\$4,607
Annual Utility Costs	\$71,607	\$55,284
Annual Savings		\$16,323

For a 1-4hr. duration energy storage system, the Demand Charge savings will typically exceed Energy time-shift savings

C/I Customer Sited ES VAR Charge Reduction Example

- ConEd example of savings from bringing customer's PF into the no-penalty zone:

The New Reactive-Power Charge and Mandatory Hourly Pricing

What You Need to Know Now, and Why

Reactive Power Information for Con Edison Bills

Reactive Power billing determinants to be presented on bill

Demand (kW)	3000
Power Factor	92.00%
Actual Reactive Power Demand (kVar)	1,200
Allowable Reactive Power Demand (kVar) at 95% Power Factor	1,000
Billable Reactive Power Demand (kVar)	200
Reactive Power Demand Charge @ \$1.10 per billable kVar	\$220.00

Reactive Power billing determinants to be presented on bill (no charge)

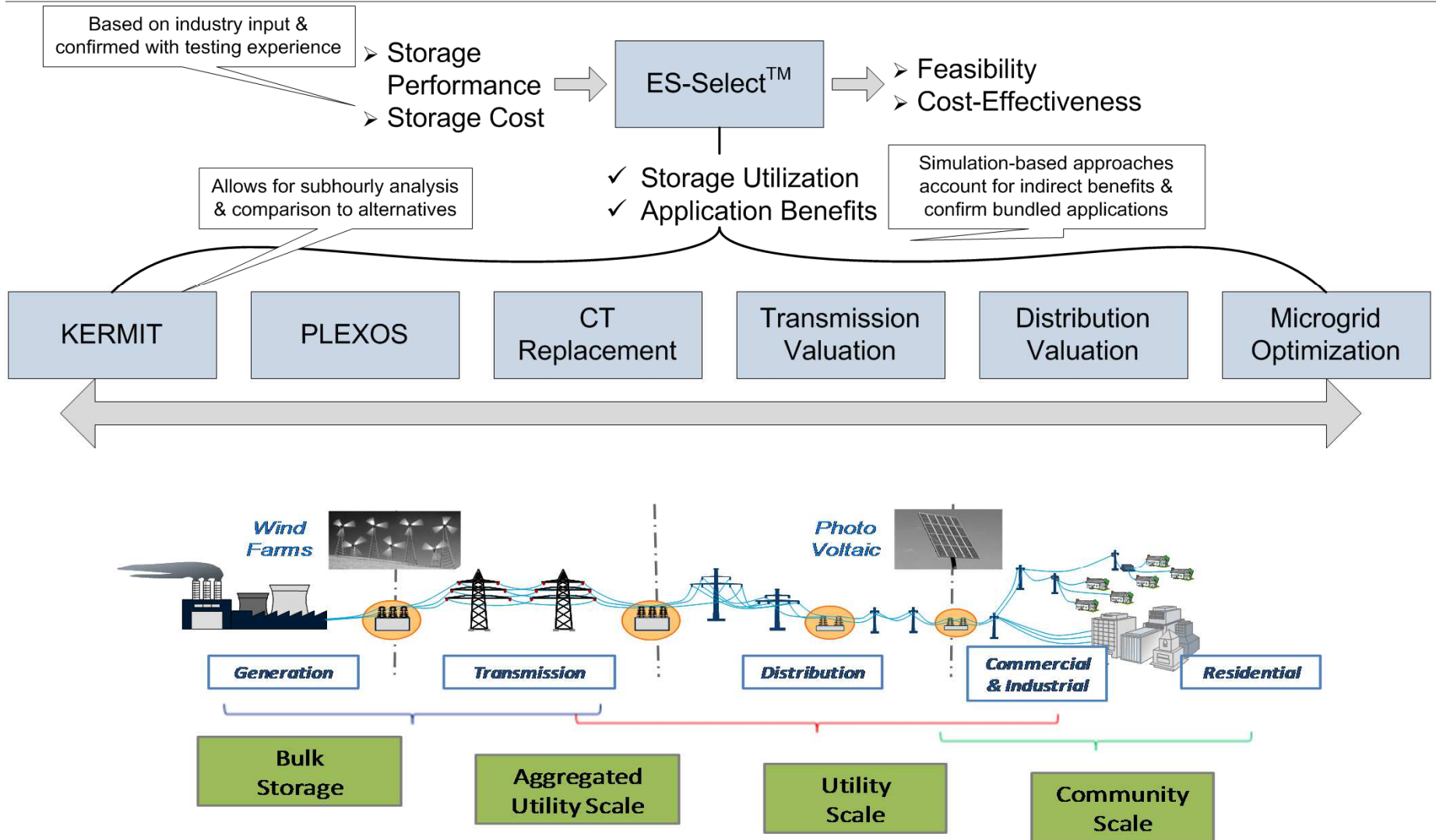
Demand (kW)	3000
Power Factor	97.00%
Actual Reactive Power Demand (kVar)	800
Allowable Reactive Power Demand (kVar) at 95% Power Factor	1,000
Billable Reactive Power Demand (kVar)	0
Reactive Power Demand Charge @ \$1.10 per billable kVar	\$0.00

- Providing VAR-support for customer-load PF correction does not consume battery capacity. It is a coincident service enabled via appropriate BESS inverter.

Contents

- 1 Introduction
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Energy Storage Valuation, Applying a Systems Perspective



Use Case Statement: Demand Side Energy Storage for Customer Bill Reduction

■ Original Use Case Statement, Customer Sited Distributed Energy Storage*

“1. Overview Section

*Electrical distribution system operation and maintenance costs are expected to increase with the growing popularity of utility customer-sited solar generation and electric vehicles. By encouraging adoption of customer-sited Distributed Energy Storage (DESS) systems through a variety of utility rate-based applications and demand response type programs, customers and third-party service providers gain more control over utility bill **energy and demand** costs while load-serving entities gain better awareness of interconnected generation, better awareness of local electrical grid conditions, and provide control strategies to help defer network upgrades and prolong asset life.”*

■ Specific implementation for Cost Effectiveness Modeling

- Common Area Load on Commercial Rate, at multi-unit residential building
- School on Commercial Rate
 - With and Without PV
- SGIP and Federal ITC as financial sensitivities

*<http://www.cpuc.ca.gov/NR/ronlyres/2676F607-09DC-411E-8E2C-67149D81C8E0/0/DSMUseCaseCustomerSide.pdf>

Use Case – Customer Sited Storage

- Customer owned, customer controlled storage device
- Storage technology - lithium-ion battery
- Primary benefit areas
 - Peak reduction
 - Energy arbitrage
 - PV time shifting
- Customer facilities evaluated
 - Common area meter of multi-family residence
 - School
- Location of evaluated facilities – San Diego
- Applicable tariff scenarios
 - 3 tier time of use (TOU) based tariff with peak demand charge – “SDGE AL TOU”
 - Flat rate tariff without demand charge – “SDGE A”



Customer Sited Storage: Financial Evaluation

- DNV KEMA's Microgrid Optimization (MGO) tool is used for demand side energy storage use case scenarios
 - MGO is being used to evaluate DOE facilities, NY State/City facilities, has been used in recent ISO distributed resource integration studies and end user planning
- Time horizon of financial evaluation is 15 years. All investments are made in year 1 (2013) and evaluated till 2027.
- Operational Notes:
 - Storage operation is simulated on a hourly basis, over 24 hour periods for the time-horizon of financial evaluation.
 - Storage is operated to co-minimize energy and demand and charges as applicable under the tariff structure of the scenario.
 - Operational benefit areas – Energy charge reduction, demand charge reduction
- Cost areas – Capital cost of storage and interface, capital cost of Solar PV (if applicable), O&M costs, financing charges
- Incentives – SGIP incentive for storage, CSI incentive for solar PV, FITC rebates for solar PV and storage (if applicable), tax benefit from accelerated depreciation

Customer Sited Storage: Input Summary

Simulation inputs

Parameter	Unit	Value
Simulation time horizon	years	15
Year of upgrade / installation	Year #	1
Number of simulated days per year	#	365
Time period of optimization	hours	1
Time horizon of optimization	hours	24

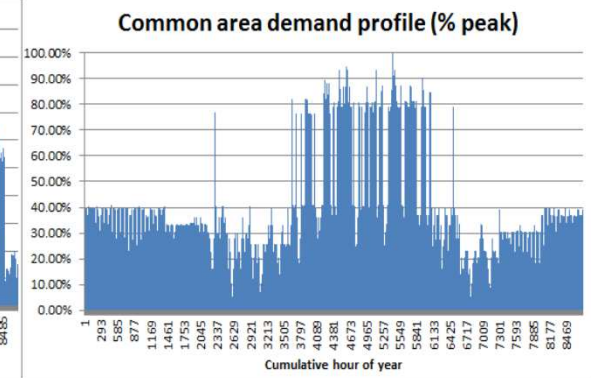
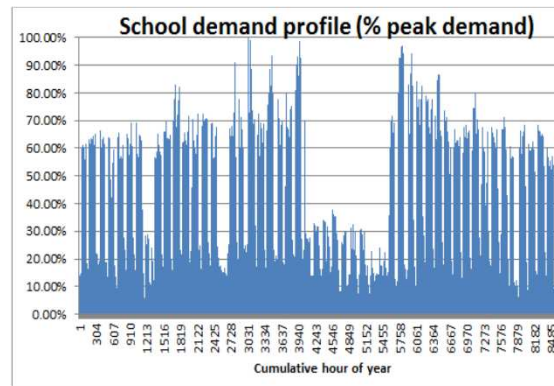
Facility inputs

Parameter	Unit	Value
Peak demand of common area meter load (2013)	KW	21.0
Peak demand of school (2013)	KW	900.0
Standard deviation of common area load	%	17.96%
Standard deviation of school load	%	19.10%
Standard deviation of temperature	%	11.67%
Load increment rate	%/year	0.30%

Cost and financial inputs

Parameter	Unit	Value		
Storage technology	—	High energy Li-Ion		
Rated power	KW	5, 50		
Discharge duration at rated power	hours	2		
Round trip storage efficiency	%	87.0%		
Round trip inverter efficiency	%	94.0%		
Installed cost of storage	2013\$/KW	Low	Med	High
		3,000	3,500	4,500
		Storage system O&M cost	2013\$/KW	\$20
		Engineering life of storage	years	15
Engineering life of inverter	years	15		
Battery initial energy level	%	0.0%		
PV Installation cost (full cost)	2013\$/KW	\$5,440		
PV Installation cost (only panels)	2013\$/KW	\$3,260		
PV Calendar life	years	20		
PV Derating factor	%/year	1.5%		
PV O&M cost	2013\$/KW	\$25		
Storage O&M escalation rate	%	2.0%		
Solar PV O&M escalation rate	%	2.0%		

Demand profiles



Customer Sited Storage: Results summary

Sc #	Scenario Characteristics				Installation			Incentives				Financial Results		
	Configuration	Customer type	Primary function	Storage cost (\$/KW)	Facility Peak Demand (KW)	Installed Storage (KW, KWhr)	Installed PV	SGIP	CSI	FITC		Acc dep	IRR	NPV
										PV	Storage			
1	Storage and Solar PV dc-coupled	Common area meter of multi-family residence	Demand reduction to shift to different tariff	Low - \$3000/KW	21	5 KW, 10 KWhr	5 KW	YES	YES	YES	YES	YES	27.03%	\$13,363
				Med - \$3500/KW									23.29%	\$12,110
				High - \$/4500/KW									17.90%	\$9,602
2	Storage and Solar PV dc-coupled	Common area meter of multi-family residence	Demand and energy charge reduction	Low - \$3000/KW	22.5	5 KW, 10 KWhr	5 KW	YES	YES	YES	YES	YES	14.55%	\$4,692
				Med - \$3500/KW									12.17%	\$3,438
				High - \$/4500/KW									8.56%	\$931
3	Storage and Solar PV ac-coupled	School	Demand and energy charge reduction	Low - \$3000/KW	900	50 KW, 100 KWhr	50 KW	YES	YES	YES	YES	YES	23.26%	\$164,918
				Med - \$3500/KW									21.02%	\$152,382
				High - \$/4500/KW									17.43%	\$127,310
4	Only Storage	School	Demand and energy charge reduction	Low - \$3000/KW	900	50 KW, 100 KWhr	50 KW	YES	NA	NA	No	YES	38.18%	\$91,391
				Med - \$3500/KW									25.56%	\$75,215
				High - \$/4500/KW									14.41%	\$42,864

Cost-effectiveness Evaluation: Conclusions – Customer Sited Storage

Customer owned and operated storage is cost-effective for facilities with high peak demand to base load ratio, under tiered TOU tariffs with high demand charges

- Facilities that were cost effective tended to have high variability in demand and high peak to base load ratio

Financing structure is critical to cost-effectiveness

- Cost-effectiveness was compared between 100% equity financed and 100% debt financed with variable financing charges.
- Other applicable customer financing scenarios can be examined.

Combined installations of solar PV and storage are more cost-effective because of the ability to capture FITC incentives on storage

CPUC June 11 Proposed Procurement Targets

- Proposed CPUC decision calls for procurement targets starting at 200MW for the three IOU's in 2014, growing to over 1 GW by 2020.
- IOU target fulfillment will include incentive payments for advanced energy storage systems within the SGIP

Table 1 - Initial Proposed Energy Storage Procurement Targets (in MW)

Use case category, by utility	2014	2016	2018	2020	Total
Southern California Edison					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal SCE	90	120	160	210	580
Pacific Gas and Electric					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal PG&E	90	120	160	210	580
San Diego Gas & Electric					
Transmission	10	15	22	33	80
Distribution	7	10	15	23	55
Customer	3	5	8	14	30
Subtotal SDG&E	20	30	45	70	165
Total - all 3 utilities	200	270	365	490	1,325

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