California Utility Scale Update

The California Energy Storage Alliance (CESA)

Chris Edgette | Senior Director

California Energy Storage Alliance

Strategen Consulting

EGRD Berlin

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Strategen Clients

Strategic thinking and industry expertise creates profitable clean energy businesses

A sampling of our clients:

BOSCH Invented for life

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CalCEF

Chevron Energy Solutions

FLUIDICENERGY

FMC

GAF GAF MATERIALS CORPORATION

DMB A Passion for Great Places

HUDSON CLEAN ENERGY

RECURRENT ENERGY

ROCKPORT CAPITAL

SHARP solar electricity

SUNPOWER

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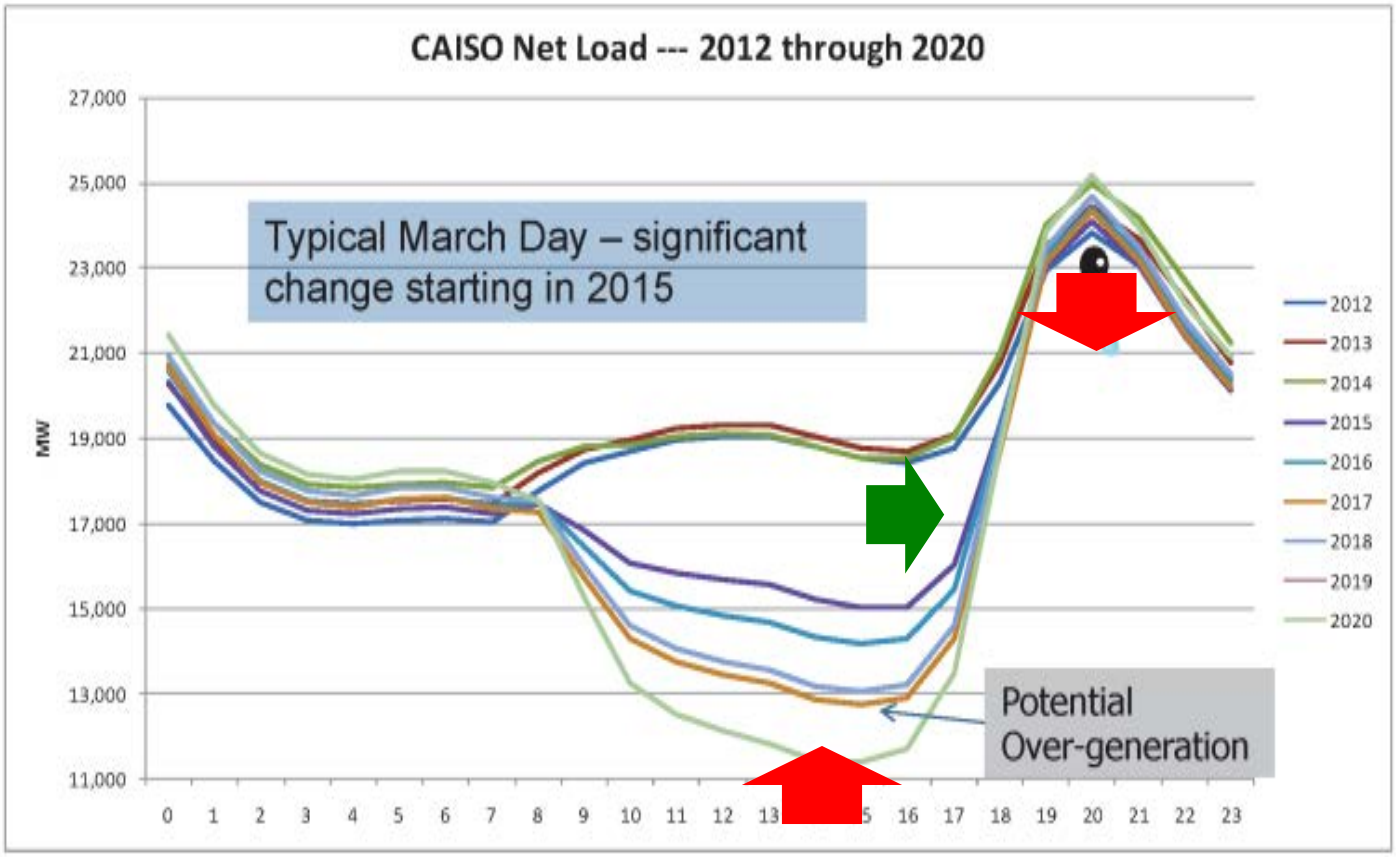
EastPenn, ecoult energy storage solutions, GE Energy Storage, green charge networks, ICE ENERGY, Invenergy, NEXTera ENERGY RESOURCES, POWERGREE, RES AMERICAS powering change, SolarCity, SUMITOMO ELECTRIC, UET

CESA 2014 MEMBERSHIP (NOW 82 STRONG!)

1 Energy Systems Inc
A123 Energy Systems
AES Energy Storage
Alton Energy
American Vanadium
Aquion Energy
ARES North America
Beacon Power, LLC
Bosch Energy
Bright Energy Storage Technologies
Brookfield
CALMAC
Chargepoint
Clean Energy Systems
Coda Energy
Consolidated Edison
Customized Energy Solutions
Demand Energy
DN Tanks
Duke Energy
Eagle Crest Energy Company
EaglePicher Technologies, LLC
EDF Renewable Energy
Enersys
EnerVault Corporation
EV Grid
FAFCO Thermal Storage Systems
FIAMM Energy Storage Solutions
Flextronics
Foresight Renewable Solutions
Greensmith Energy
Gridscape Solutions
Gridtential Energy, Inc.
Halotechnics
Hitachi Chemical Co.
Hydrogenics
Imergy Power Systems
ImMODO Energy Services Corporation
K&L Gates
KYOCERA Solar, Inc.
LG Chem
LightSail Energy
LS Power Development, LLC
NRG Solar LLC
OCI Company
OutBack Power Technologies
Panasonic
Parker Hannifin Corporation
PDE Total Energy Solutions
Primus Power Corporation
Recurrent Energy
Rosendin Electric
S&C Electric Company
Saft America Inc.
Samsung
SEEO
Sharp Electronics Corporation
Sovereign Energy Storage LLC
STEM
Stoel Rives
SunEdison
SunPower
TAS Energy
Trimark Associates, Inc.
Tri-Technic
Wellhead Electric

Energy Storage Can Address California's Net Load



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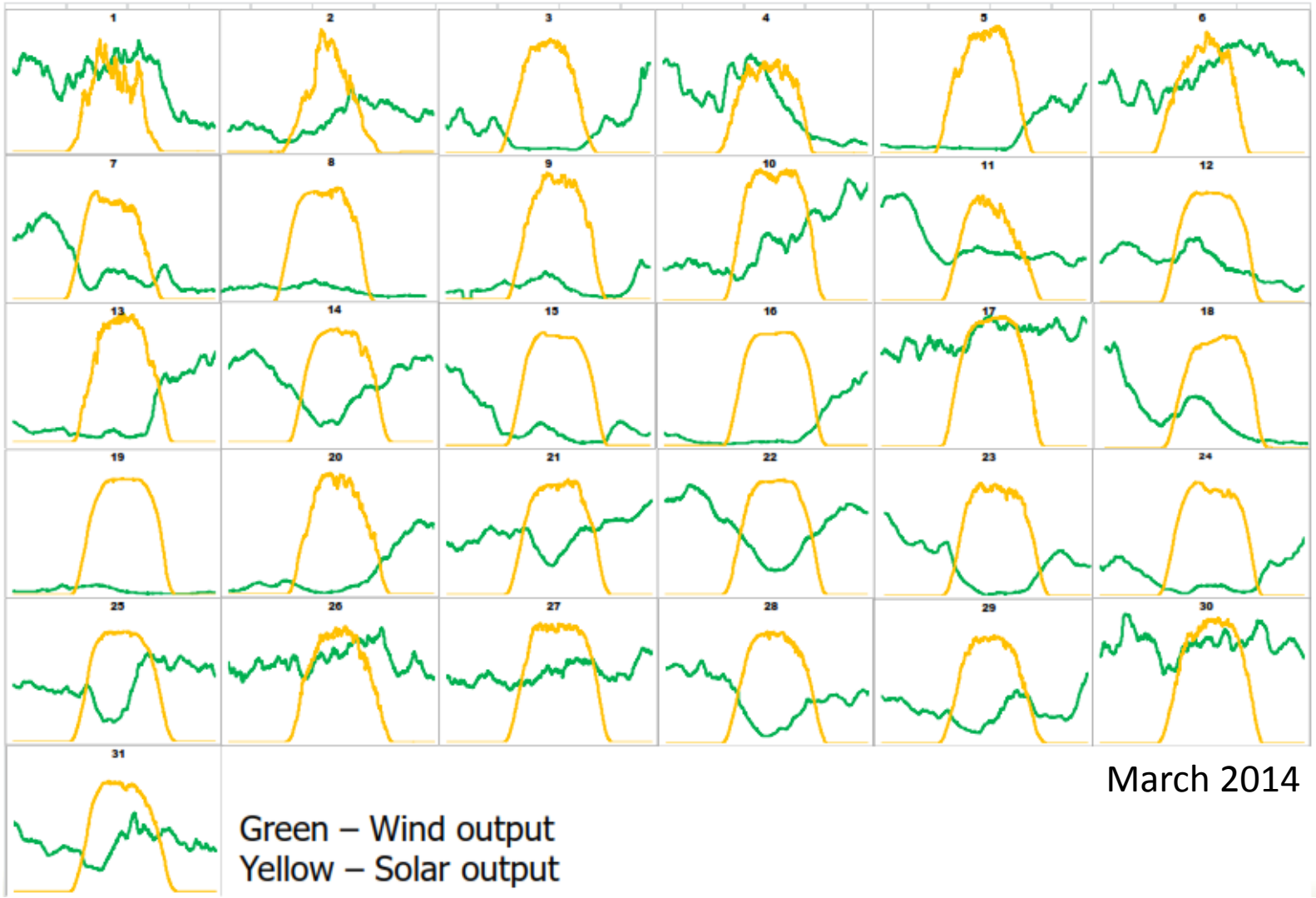
Renewable Output in California



Source: CAISO 2014 Flex Capacity Needs Assessment

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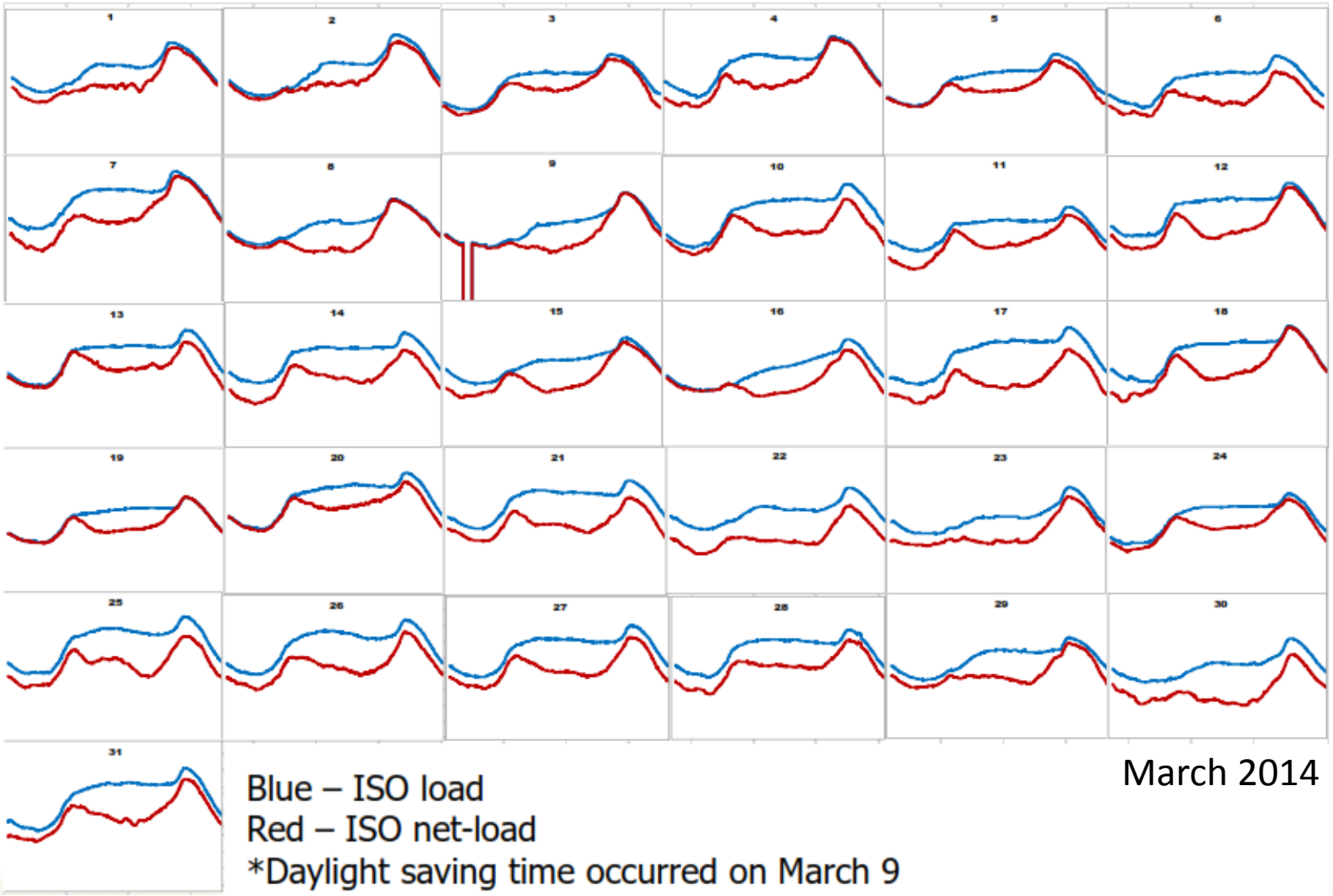
Renewable Effect on California Net Load



Source: CAISO 2014 Flex Capacity Needs Assessment

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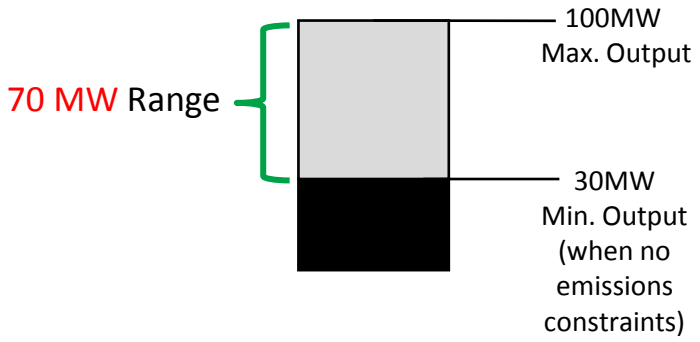
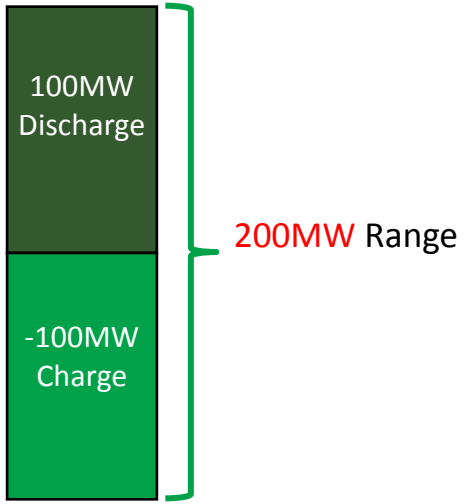
Energy Storage: ~3X the Flexible Range per MW

Compare benefits, not megawatts





100MW LMS 100 Gas Peaker Plant[1]

100MW Energy Storage System

1. LMS Plant Picture Source: http://www.industcards.com/cc-usa-ca-n.htm (Panoche Power Plant, Firebaugh, CA)

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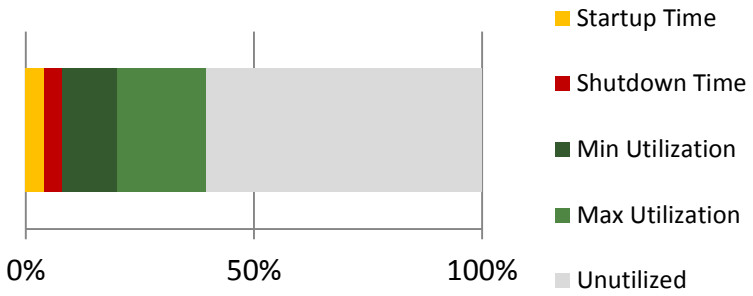
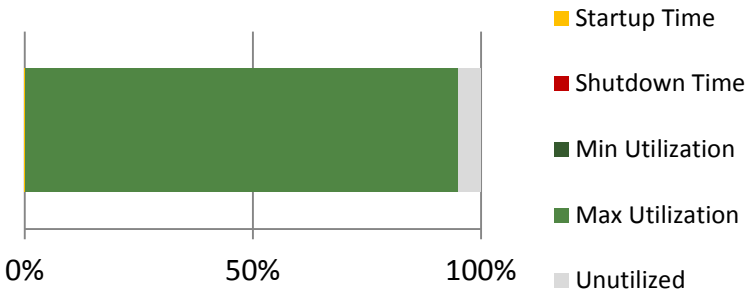
Energy Storage: 3X the Utilization



20%-40%

Utilization

100 MW LMS 100 Gas Peaker Plant[1]



>95%

Utilization

100MW Energy Storage System

1. LMS Plant Picture Source: http://www.industcards.com/cc-usa-ca-n.htm (Panoche Power Plant, Firebaugh, CA)

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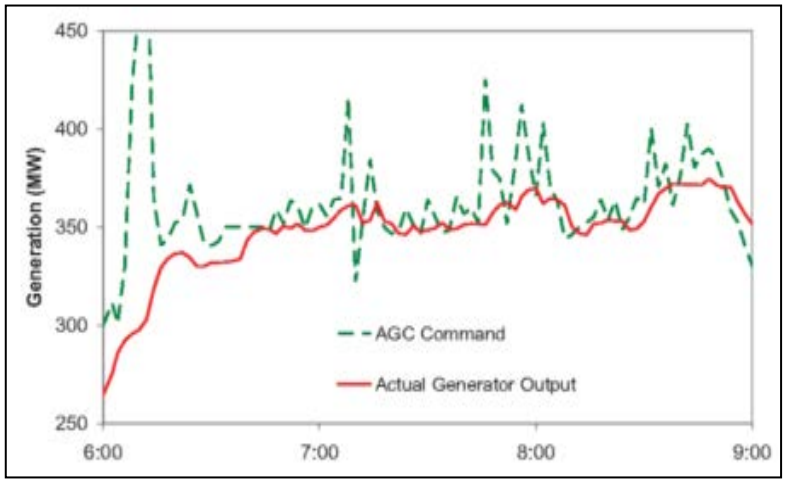
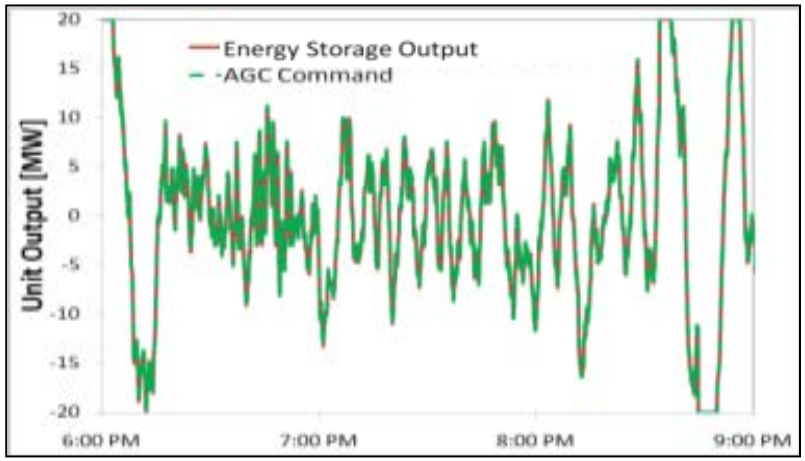
Energy Storage Responds More Quickly





LMS 100 Gas Peaker Plant

Full Power Ramp 10 Minutes

Energy Storage System

Full Power Ramp <1 second

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

1. http://www.cpvsentinel.com/about.html

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Emission Impacts Due to Cycling CCGTs & CTs

NREL concluded that cycling conventional power plants has significant impacts on emissions

CO_2 Emissions Penalties[1]			
Power Plant Type	**Part-Load[2]**	**Ramping[3]**	**Start/Stop**
Gas Combined Cycle (CCGT)	15%	1%	30%
Gas Combustion Turbine (CT)	17%	1%	40%

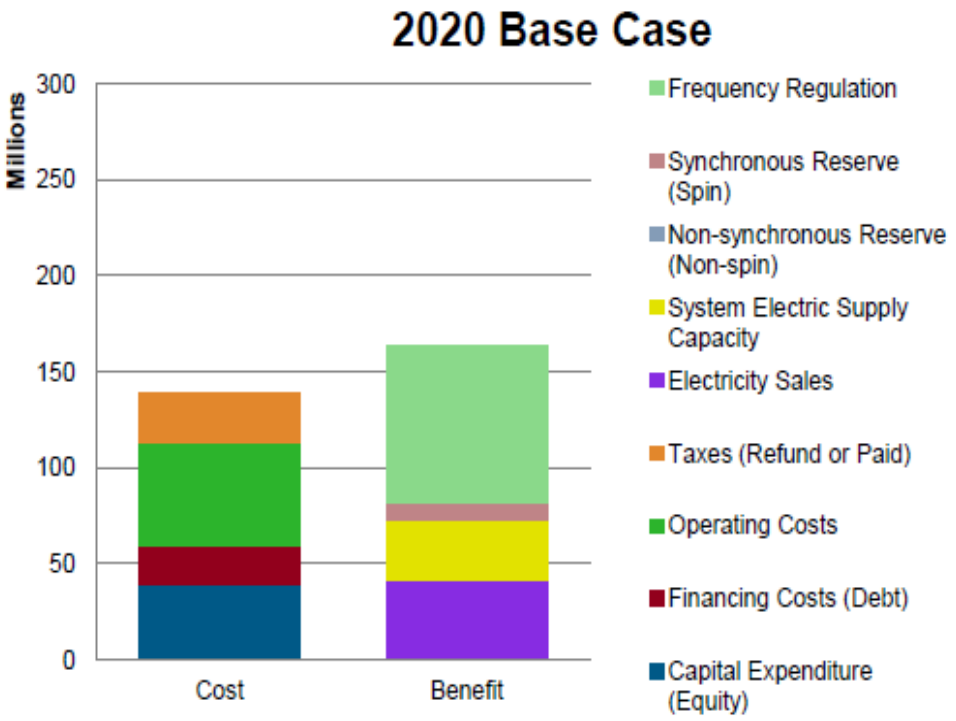
NO_X Emissions Penalties[1]			
Power Plant Type	**Part-Load[2]**	**Ramping[3]**	**Start/Stop**
Gas Combined Cycle (CC)	29%	8%	610%
Gas Combustion Turbine (CT)	16%	1%	180%

1) Listed as percentage penalty over the equivalent full-load operation for one hour
2) Assumes operation at 50% of capacity
3) Ramping leads to far less emissions compared to startups, but occurs more often

Source: National Renewable Energy Laboratory (NREL/PR-6A20-55828): *Impacts of Renewable Generation on Fossil Fuel Unit Cycling: Costs and Emissions* (May 20, 2012)

Results: Bulk Peaking Power Plant

Application	Bulk Peaker
Benefits	Capacity
	Energy
	Frequency Regulation
	Spinning Reserve
	Non-Spinning Reserve
Benefit to Cost Ratio	1.17
Breakeven Capital Cost	$831/kWh ($1662/kW)



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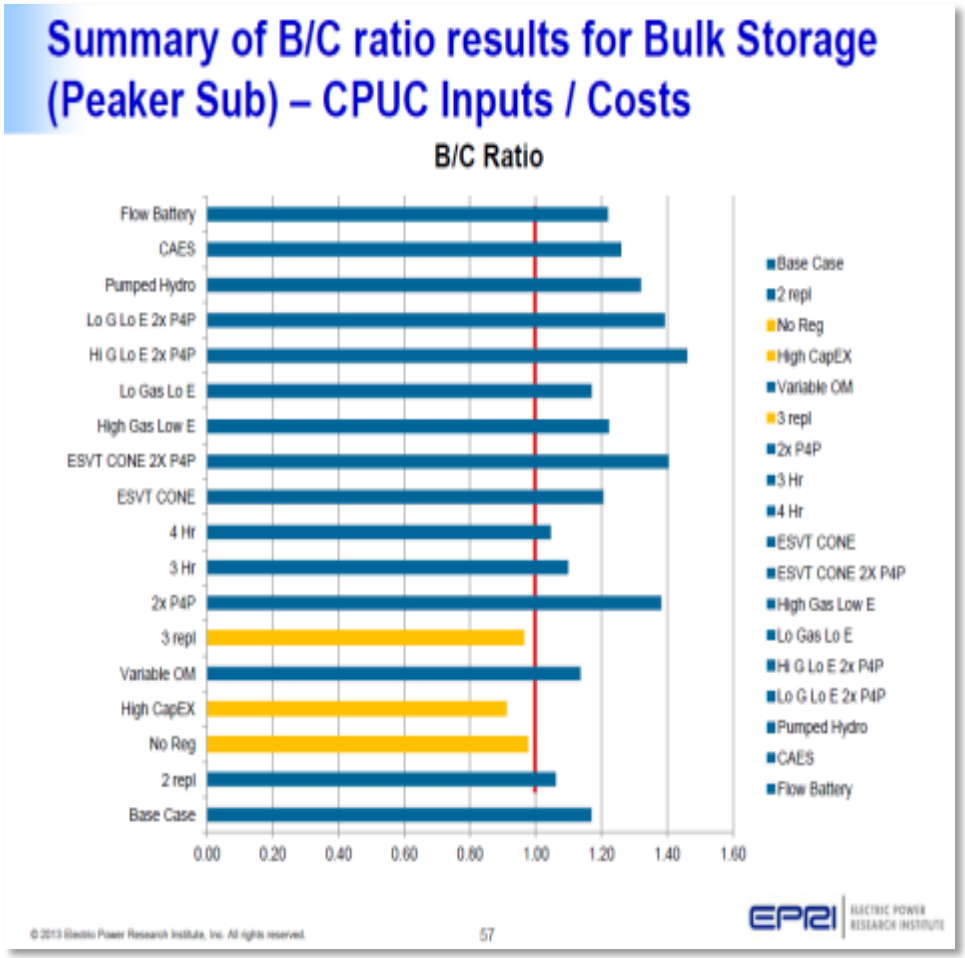
Results: Bulk Peaking Power Plant

Preliminary results by EPRI using stakeholder input showed a benefit to cost ratio over one for nearly every scenario



- Projects were assumed to be utility scale projects starting in 2015 and 2020
- Cost effectiveness results did not include GHG benefits of storage or GHG costs due to AB32 implementation
- High renewable penetration cases had the highest benefit to cost ratios for storage.
- GHG benefits for storage are greater the more renewables we have on the grid.

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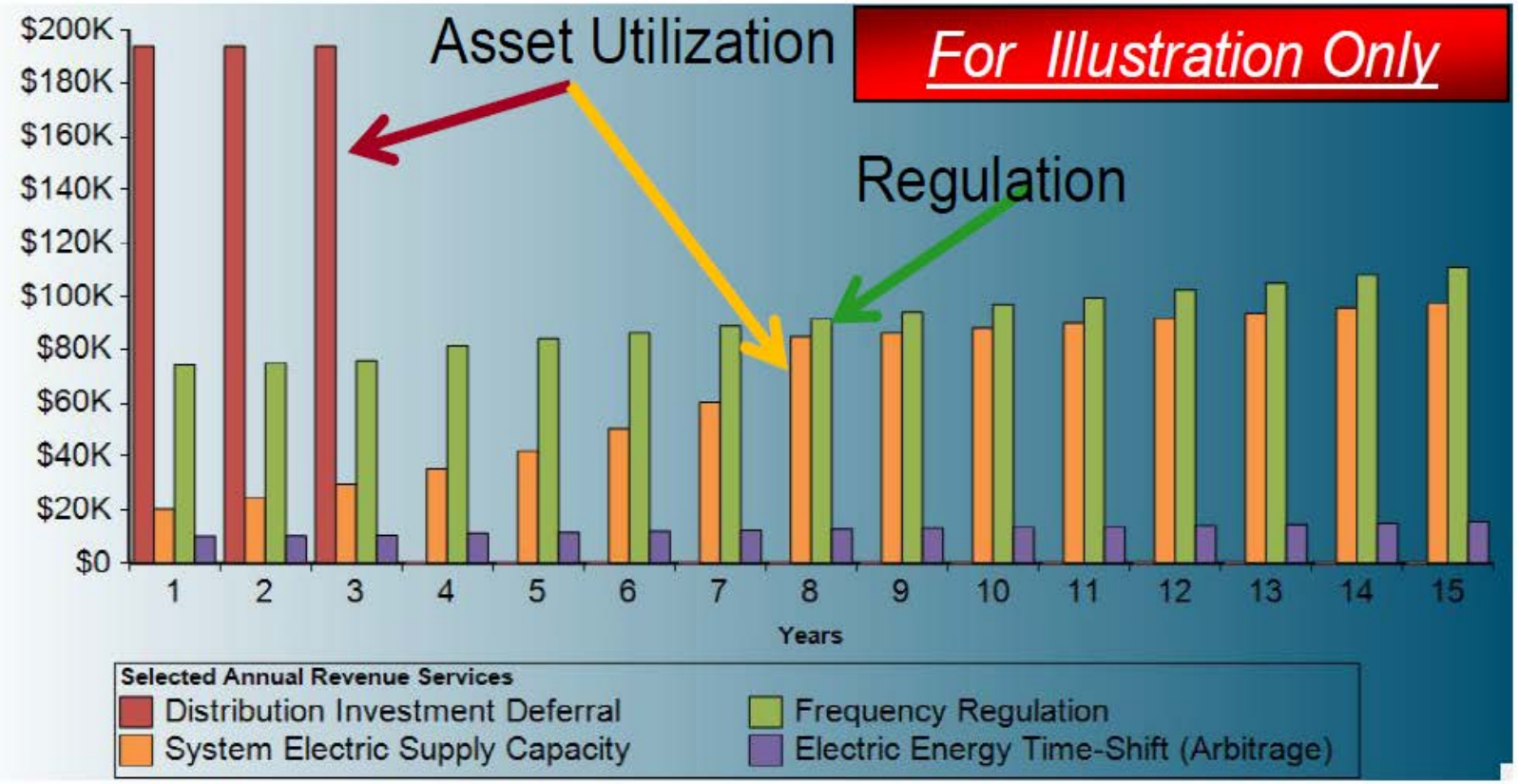
Results: Distribution Storage at Substation



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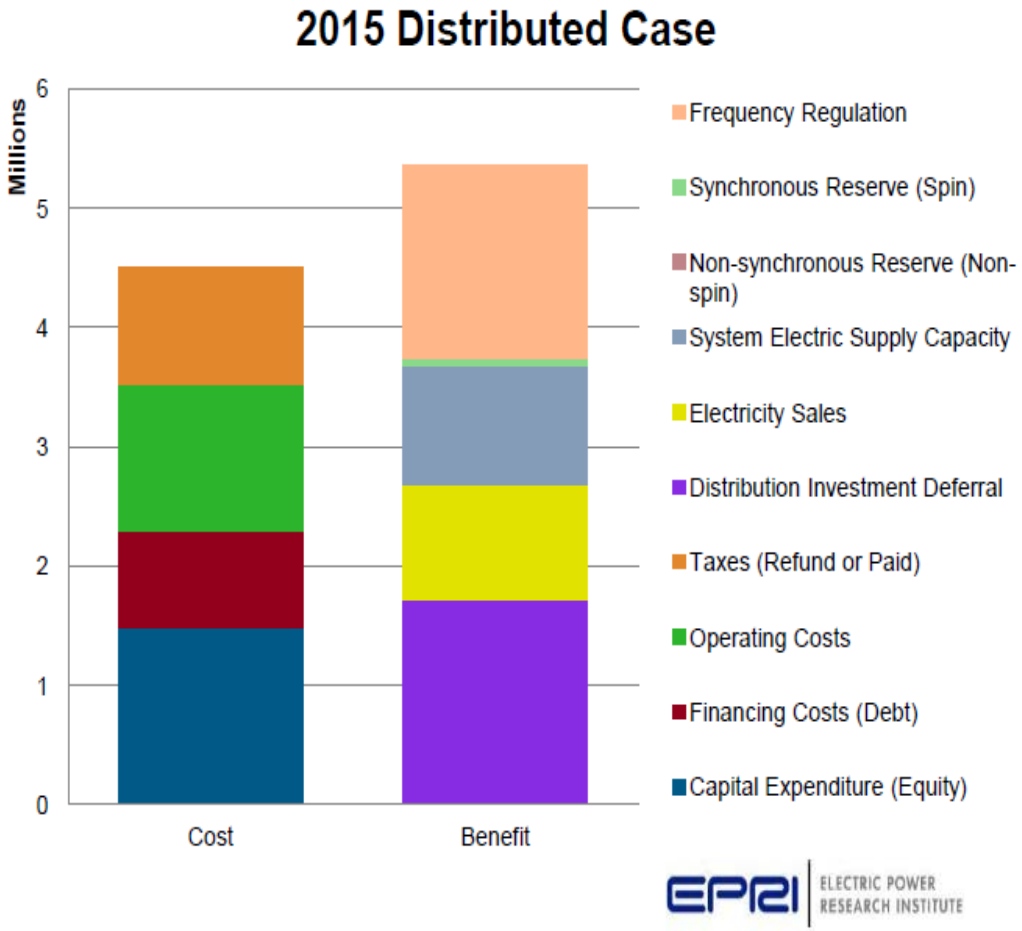
Results: Distribution Storage at Substation

Application	Distribution Storage
Benefits	Upgrade Deferral
	Energy
	Frequency Regulation
	Spinning Reserve
	Non-Spinning Reserve
Benefit to Cost Ratio	1.19
Breakeven Capital Cost	$851/kWh ($3403/kW)



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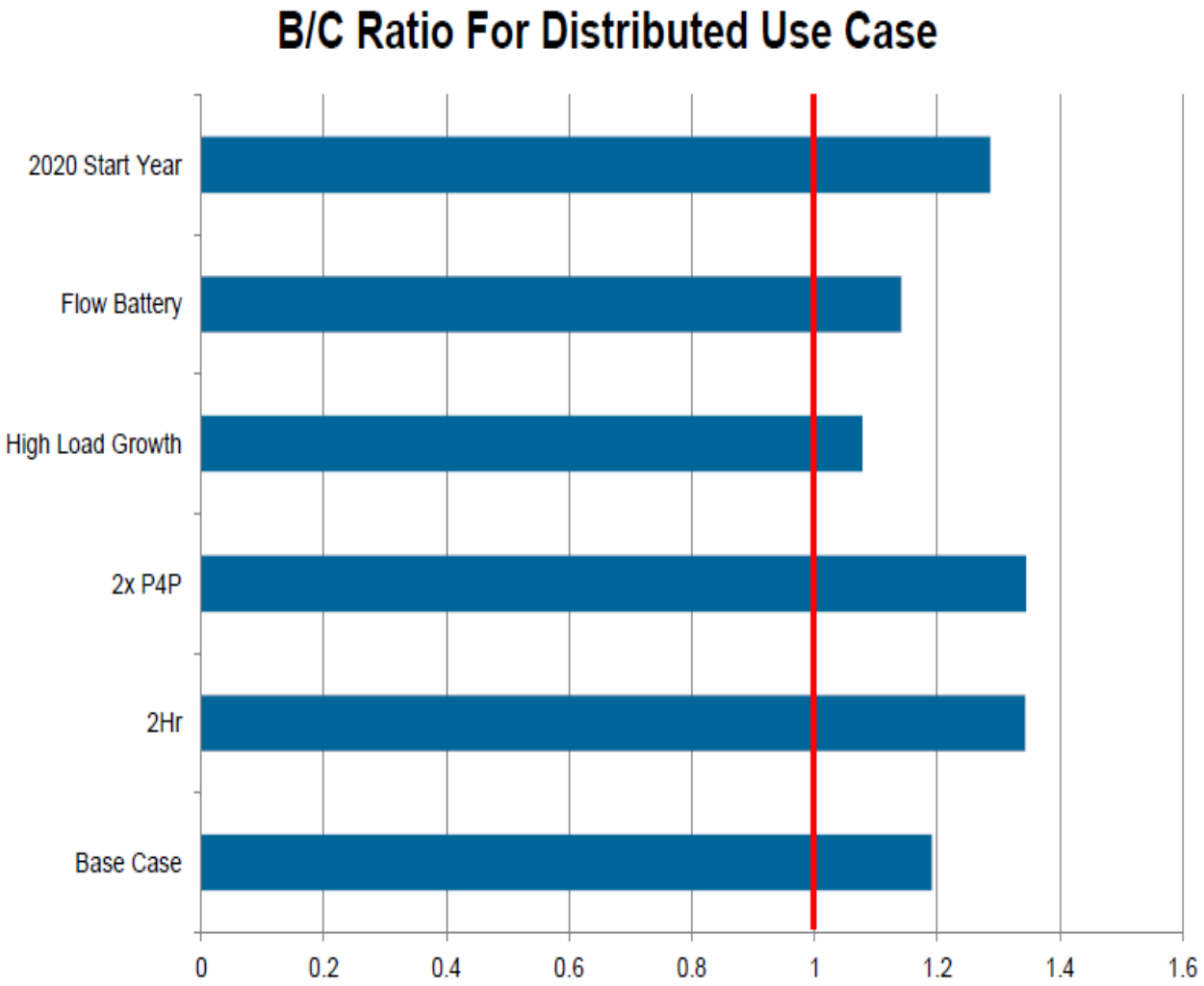
Results: Distribution Storage at Substation



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Energy Storage Procurement Targets

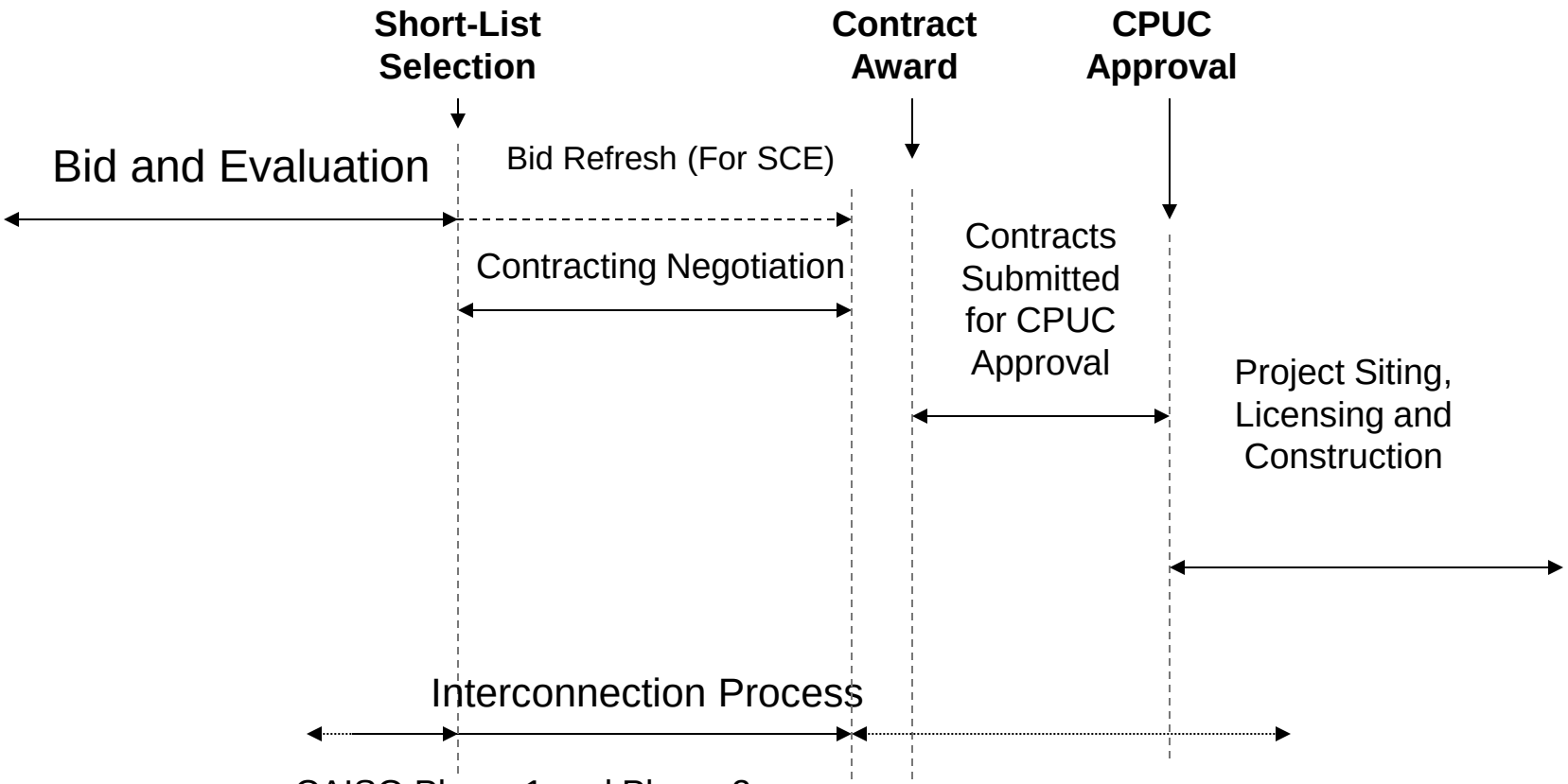
Storage Grid Domain Point of Interconnection	2014	2016	2018	2020	Total
Southern California Edison					
Transmission	50	65	85	110	310
Distribution	30	40	50	65	185
Customer	10	15	25	35	85
Subtotal SCE	**90**	**120**	**160**	**210**	**580**
Pacific Gas & Electric					
Transmission	50	65	85	110	310
Distribution	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**

RFO Proposed Schedule for California IOUs

Event	SCE	SDG&E	PG&E
RFO Launch	December 1, 2014	Prior to December 1, 2014	December 1, 2014
Bidders' Conference	December 17, 2014	May conduct 'stakeholder outreach' prior to RFO launch / bidder's conference after	December 18, 2014
Offer deadline	February 16, 2015	Not specified	February 27, 2015
Short-List Notification	April 1, 2015	Not specified	June 30, 2015
Negotiation deadline	August 14, 2015	Not specified	N/A
Final Offer deadline	September 1, 2015	Not specified	N/A
Final Selection	September 20, 2015	Not specified	TBD
Advice Letter or Application Filing	December 30, 2015	Not specified	12 months after shortlist

Source: CPUC Energy Storage Procurement Applications Workshop March 14, 2014

Bidding and Contracting Timeline - Simplified



CAISO Phase 1 and Phase 2

(Note that SCE requires that the Phase 1 study to be completed before it will accept the final modified contract terms and bid refresh.)[1]

Utility Generation Interconnection Agreement

1: See SCE's Interconnection Matrix at https://www.sce.com/wps/wcm/connect/dcb062be-0759-414c-83a5-da0aba7d75b6/SCE_InterconnectionMatrix.pdf?MOD=AJPERES

Net Market Value (PG&E Evaluation Discussion)

Co-optimize Energy, A/S, Variable Cost = Charging/Discharging

+ Net Energy Value

- Value of discharging – cost of charging using projected LMP

+ Ancillary Services Value

- Regulation Up/Down/REM, Spin in a limited market

+ Capacity Value

- Generic Resource Adequacy using Net Qualifying Capacity
- Flexible RA using Effective Flexible Capacity

- Variable Cost

- Variable O&M price applied over *discharge* schedule
- Includes fuel and start-up costs plus GMC, but not charging cost

- Fixed Cost

- Sum of capacity payment price times monthly contract capacity
- Fixed overhead (administrative costs plus cost of CAISO scheduling)

Source: PG&E Presentation at CPUC Energy Storage Procurement Applications Workshop March 14, 2014

Quantitative Adjustments

Adjustments for Localized Benefits and Portfolio Effects

+/- Location

- Preference for NP15 projects
- Local Capacity Requirement may warrant premium

- Transmission Network Upgrade Cost

- This is past first point of interconnection; cost to interconnect in bid

+ Transmission/Distribution Investment Deferral Value

- NPV of least expensive non-storage alternative
- If dual-use, meet reliability need first, remaining hours play in market

+ Increased Efficiency for Fossil Generation

- Value to smoothing out net load => fewer starts, better efficiency
- Portfolio-wide benefit, will probably depend on generic characteristics

+ Renewable Generation Curtailment Support

- Also portfolio-wide: benefit of reduced curtailment, increased RPS

Source: PG&E Presentation at CPUC Energy Storage Procurement Applications Workshop March 14, 2014

Wholesale vs. retail rate treatment is a key issue

Interconnection Type		Storage Input Energy Function	Wholesale vs. Retail	Comments
Transmission Connected	1	Storage charging during REM	Wholesale	Includes RTE Losses
	2	Storage charging for Non-REM wholesale market functions	Wholesale	Includes RTE Losses
	3	Storage charging for Transmission Support activities	Wholesale	Includes RTE Losses
	4	Pre-chilling of a thermal resource that directly offsets chilling at a later time	Wholesale	
Distribution Connected	1	Storage charging for REM	Wholesale	Includes RTE Losses
	2	Storage charging for Non-REM wholesale market functions	Wholesale	Includes RTE Losses
	3	Storage charging for Distribution Support activities	Wholesale	Includes RTE Losses
	4	Pre-chilling of a thermal resource that directly offsets chilling at a later time	Wholesale	
Behind the Meter	1	Storage charging during REM	Wholesale	
	2	Storage charging for Non-REM wholesale market functions	Wholesale	
	3	Storage charging to offset customer load	Retail	
	4	Storage charging to provide Demand Side DR	Retail	
	5	Storage charging to provide Supply Side DR	TBD	
	6	Ancillary battery heating/cooling	Retail	
	7	Pre-chilling of a thermal resource that directly offsets chilling at a later time	Retail	

The biggest dispute is about what is included in Round Trip Efficiency (RTE)

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SCE's LTPP Energy Storage Requirement

Resource Type	Track 1 LCR Resources (D.13-02-015)	Additional Track 4 Authorization	Total Authorization
Preferred Resources **Minimum Requirement**	150 MW	400 MW	550 MW
Energy Storage **Minimum Requirement**	50 MW	--	50 MW
Gas-fired Generation **Minimum Requirement**	1000 MW	--	1000 MW
Optional Additional From Preferred Resources/Energy Storage Only	Up to 400MW		Up to 400 MW
Additional from any Resource	200 MW	100 to 300 MW	300 to 500 MW
Total Procurement Authorization	**1400 to 1800 MW**	**500 to 700 MW**	**1900 to 2500 MW**

Source: SCE Procurement Authorization And Requirements (Track 1 + Track 4)

SDG&E's LTPP Energy Storage Requirement

Resource Type	D.13-03-029/ D.14-02-016	Additional Track 4 Authorization	Total Authorization
Preferred Resources (including energy storage) **Minimum Requirement**	---	175 MW	175 MW
Energy Storage **Minimum Requirement**	---	25 MW	25 MW
Additional from any resource	300 (Pio Pico)	300 to 600 MW	600 to 900 MW
Total Procurement Authorization	**300 MW**	**500 to 800 MW**	**800 to 1100 MW**

Source: SDG&E Procurement Authorization and Requirements

Other Utility Procurement

- In January 2014, the Imperial Irrigation District announced a solicitation of **20 to 40 MW** of battery energy storage.

- In August 2014, the City of Redding issued an Energy Storage Compliance Plan that approved energy storage targets of **8 MW by 2020.**

Procurement Outside California

- **Hawaii**
  - HECO issued 200MW storage RFP (April, 2014)
  - HELCO issues 92% renewable plan (Sept, 2014)
- **New York ISO** - Reforming the Energy Vision (REV) Initiative
- **PJM** - Nearly 100MW of storage already on the grid
- **Arizona** - APS and the Residential Utility Consumer Office (RUCO) settlement requires energy storage evaluation in procurement
- **Puerto Rico** - All new renewables projects must include specific storage capabilities, but politics are challenging.
- **ERCOT** - Conducting stakeholder process to redesign ancillary services market
- Northwest US
  - **Washington State** – $14m matching grant to deploy storage (July 14')
  - **Oregon** – PGE owns a 5MW Li-ion project/ DOE accepting considerations on funding storage.

Utility Use Cases

Transmission Sited	**Standalone**	Transmission Deferral & NERC Reliability
		Dual Use (Partial Rate Based, Partial Market Participant)
		Bulk Peaker (Energy & AS)
		AS Only
	Generator Paired	Storage with wind
		Storage with PV
		Molten salt storage with Concentrating Solar
		Thermal + Turbine Inlet Chilling or CAES
		Hybrid Thermal + Fast Response Storage
		Thermal + Oxygen Chilling
Distribution Sited	**Standalone**	Distribution Upgrade Deferral
		Community Energy Storage
	Generator Paired	Community Energy Storage + Renewables
Customer Sited	**Bill Management & Demand Response**	Business Customer, Peak/Max Demand Mgt.
		Residential Customer, TOU Bill Management
		Residential Customer, Solar Integration and bill management
		Aggregated C&I / Virtual Net Meter Solar + Storage
		Multi-family Residential, Solar and Demand Mgt.
	Bill Management + Market Participation	Business Customer, Bill + Market Participation
		Residential Customer, Bill + Market Participation
	Utility Controlled	Grid Operation Benefits – Distribution Upgrade Deferral
	EV Charging	Solar + Storage + EVs with bidirectional mkt participation
		Storage + EVs with bidirectional mkt participation
		EV Aggregated Charging with Market Participation (V1G)
		EV Aggregated Charging/Discharging with Market Participation (V2G)

What is the latest?

» The current structure identifies the critical issues as shown:

Actions		Barriers							
		Ancillary services	Financial	Interconnection	Market and regulations	Metering	Modeling	Standards	Telemetry
Revenue opportunity	Defining and communicating grid needs will clarify gaps help identify new products		X	X	X				
	Clarify existing wholesale market product opportunities for storage	X	X		X				
	Refine existing and add new wholesale market products to meet grid needs	X	X		X				
	Identify gaps in rate treatment and identify existing rules that could address issues	X	X		X				
	Define multiple-use applications of storage to facilitate development of models and rules		X		X				
	Determine hybrid storage configurations to enable prioritization and development of requirements		X		X		X	X	
	Assess existing methodologies for evaluating storage and identify or develop a preferred common methodology		X				X	X	
Cost reduction	Review metering requirements for opportunities to reduce costs					X			X
	Review telemetry requirements for opportunities to reduce costs							X	
	Assess codes and standards to identify gaps and best practices			X	X	X			X
	Review interconnection process for small distribution-connected resources			X					
Process and timing	Clarify interconnection processes to make it predictable and transparent			X					

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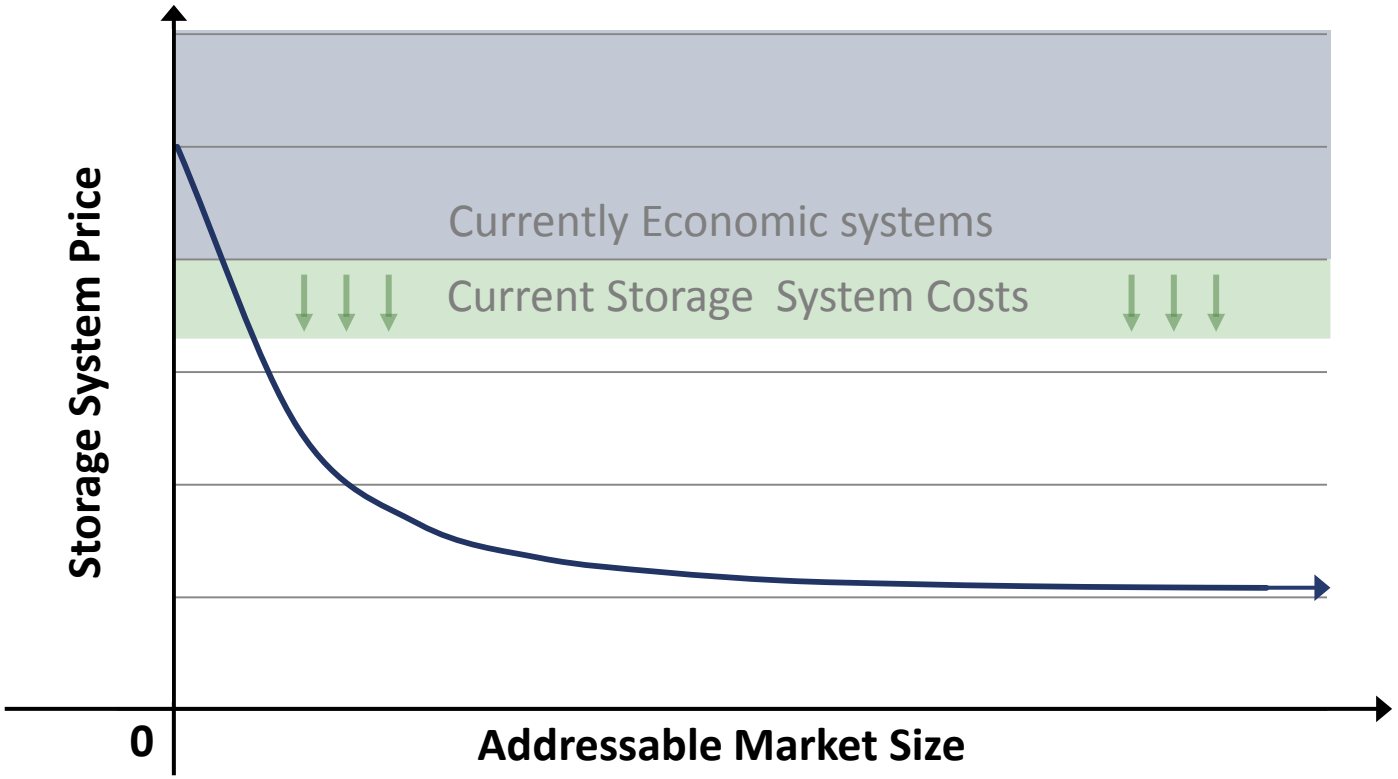
Conceptual View of the Storage Market

» Storage is economic today in locations and applications with high value



» As costs go down, the number of applicable applications and markets grows

» The process accelerates if we give the learning curve a gentle push

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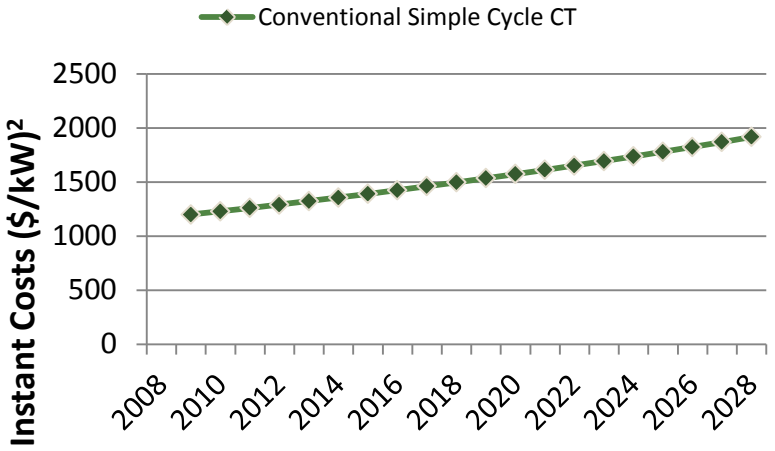
What is at stake?

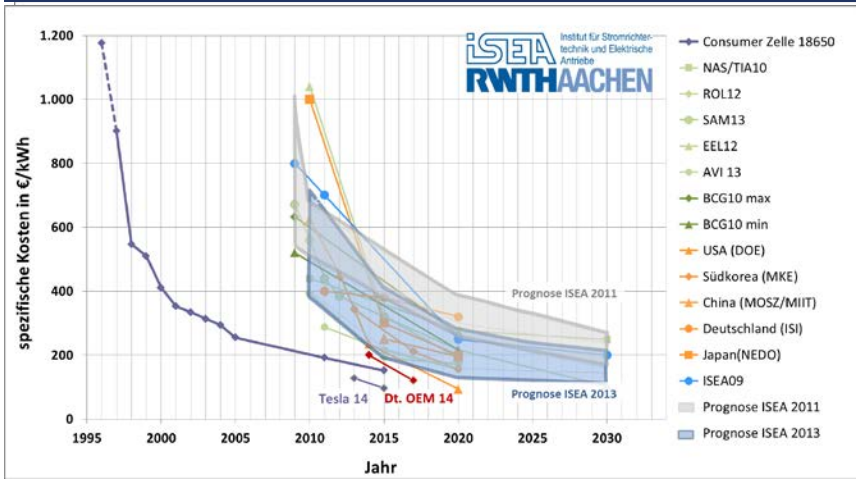
- Greater system flexibility without changing customer behavior
- Faster response from grid assets
- Improved customer reliability
- Greater energy security
- Lower emissions
- Better renewable integration
- Opportunity to “leapfrog” traditional grid in developing regions

Which technologies should we invest in?

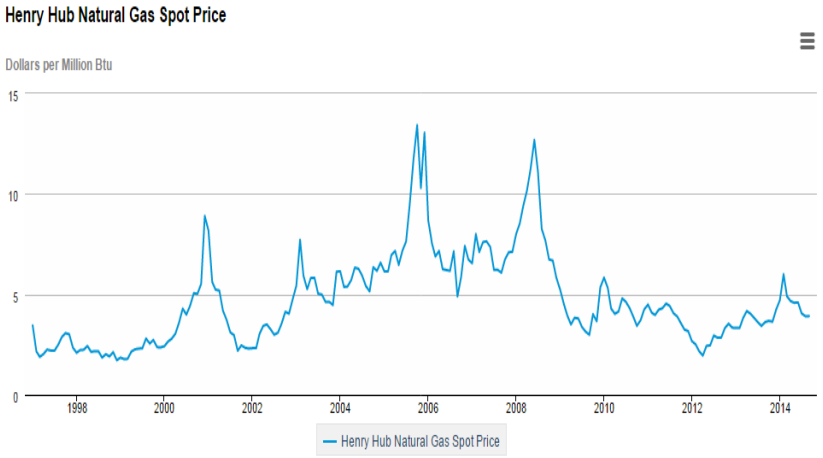
Fossil Generation - CAPEX



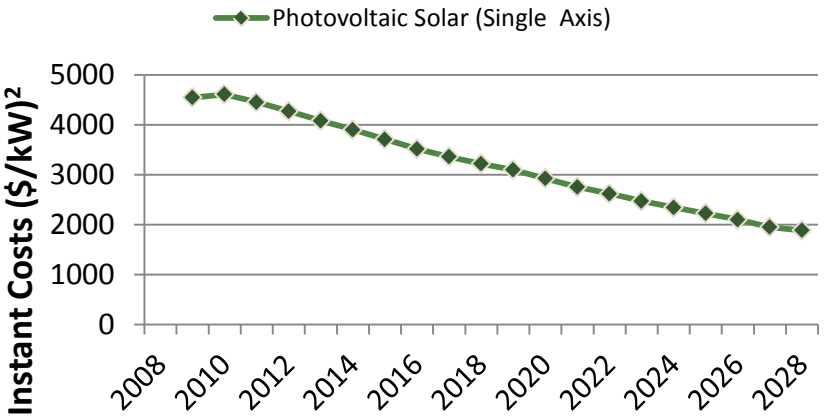
Energy Storage - CAPEX



Fossil Generation – Fuel Cost[3]



Energy Storage – Fuel Cost[1]



1. Source: California Energy Commission
2. 2009 starting dollars, escalated at 2.5% per year
3. US Energy Information Administration

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More Information

Vielen Dank!

Chris Edgette, Senior Director

- Email: cedgette@strategen.com
- Office: +1 510 665 7811 x 102
- Mobile: +1 415 424 8475