Imperative of Energy Storage for Meeting California's Clean Energy Needs

Prepared for the Senate Energy, Utilities and Communications Committee

The California Energy Storage Alliance (CESA)

Janice Lin | CESA Co-Founder and Director

June 22, 2010

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Overview

- CESA Overview – Why California?
- The Market for Grid Connected Energy Storage
- Benefits of Energy Storage
- Overview of AB 2514 - Why a Mandate is Necessary
- Other California Energy Storage Regulatory Activities
- Summary

CESA was founded by energy storage leaders in January 2009

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

Steering Committee:

ALTAIR NANO

AIC Applied Intellectual Capital VENTURES IN SUSTAINABLE TECHNOLOGY

EAST PENN International

Beacon POWER

ICE ENERGY

Chevron

Human Energy

FLUIDICENERGY

Other Members:

A123 SYSTEMS

Deeya Energy

Debenham Energy, LLC

EnerSys

EnerVault Launching a Clean & Secure Energy Future

Powergetics Intelligent energy for the human race

Prudent Energy

PVT SOLAR

SAMSUNG SDI SAMSUNG

SUNTECH

SustainX ENERGY STORAGE SOLUTIONS

Xtreme Power

DOUGLASS & LIDDELL ATTORNEYS AT LAW

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Why California? Energy storage is fundamental to many key California policy initiatives

- ‘Foundational’ Legislation
  - Energy Storage Procurement Targets: ESPS (AB 2514, introduced)
  - RPS Legislation (SB 722, introduced)
  - 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)

- Active regulatory implementation of legislation at California Public Utility Commission & California Air Resources Board

- Incentives available for customer sited applications via SGIP: $300-450M

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

- Many CA storage projects currently underway (list in appendix)

CESA is driving results-oriented change in all of these areas

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)

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Examples of Advanced Energy Storage Projects:

5 MW Thermal Storage – LA Community College (Calmac)

115 MW Compressed Air Energy Storage

500 kW Mobile Zinc Flow Battery Storage

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

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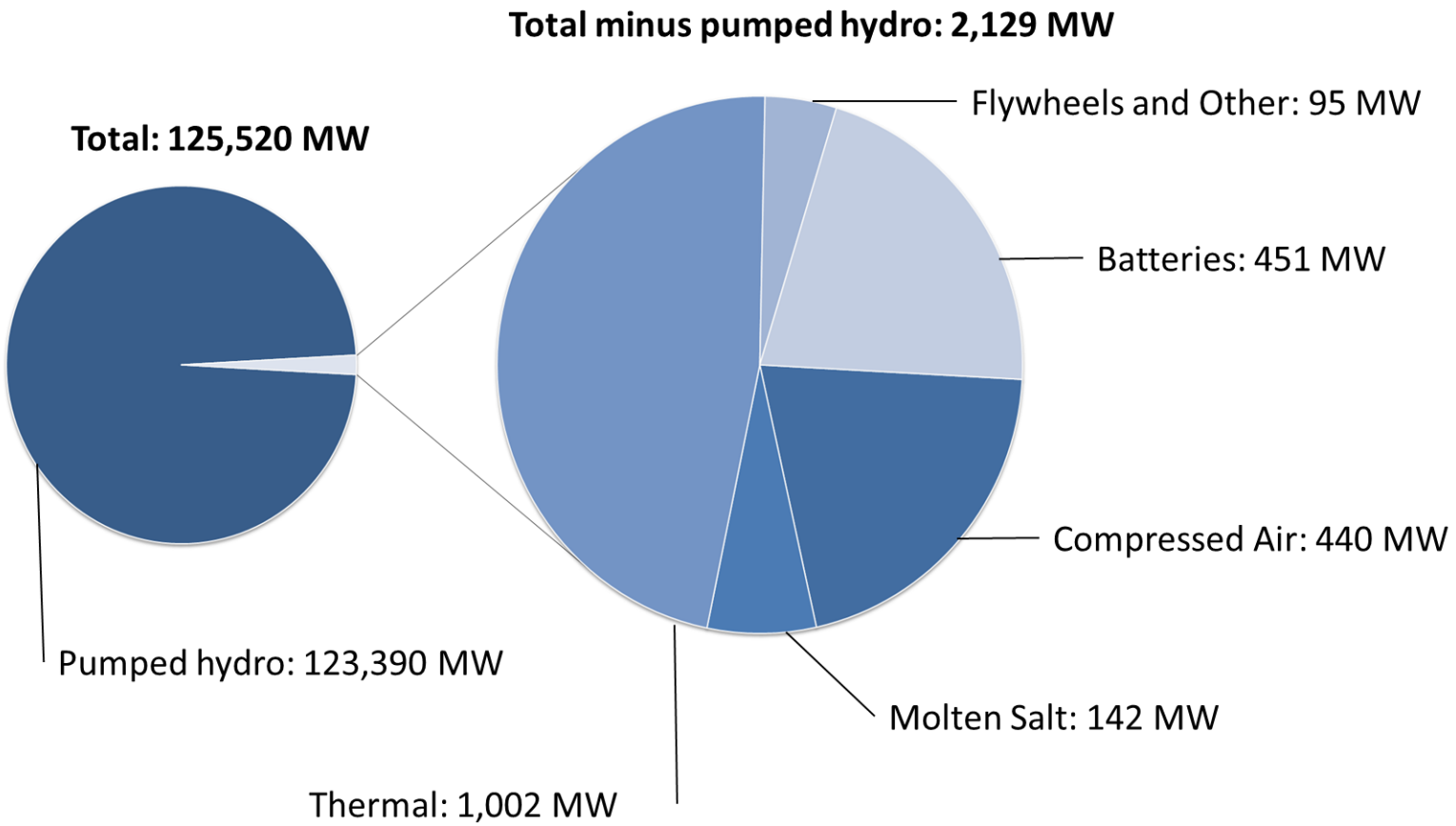
The Grid Connected Energy Storage Market is Large …

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.

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… 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

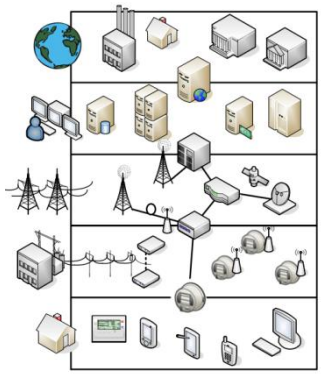
Source: StrateGen Consulting, LLC research; thermal storage installed and announced capacity estimated by Ice Energy and Calmac,
Estimates include thermal energy storage for cooling only.
Figures current as of March, 2010.

Key Drivers of Growth for Grid Storage

Smart Grid

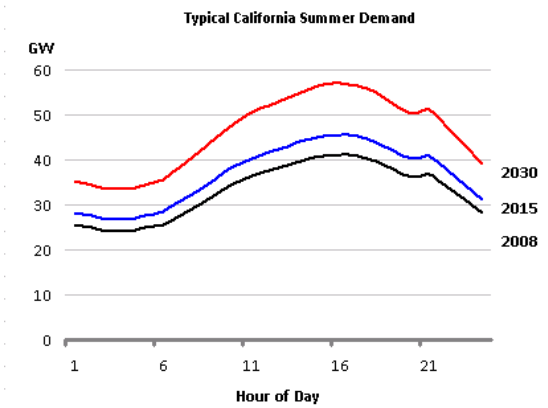
"Our expectation is that this [smart grid] network will be 100 or 1,000 times larger than the Internet"

- Cisco, May 2009

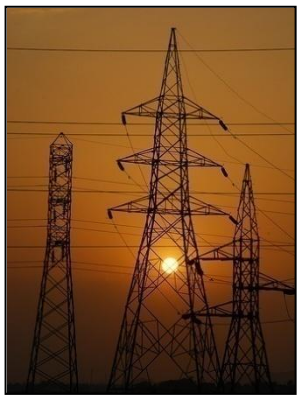


Renewables Integration

Peak Load Growth



Transmission Constraints



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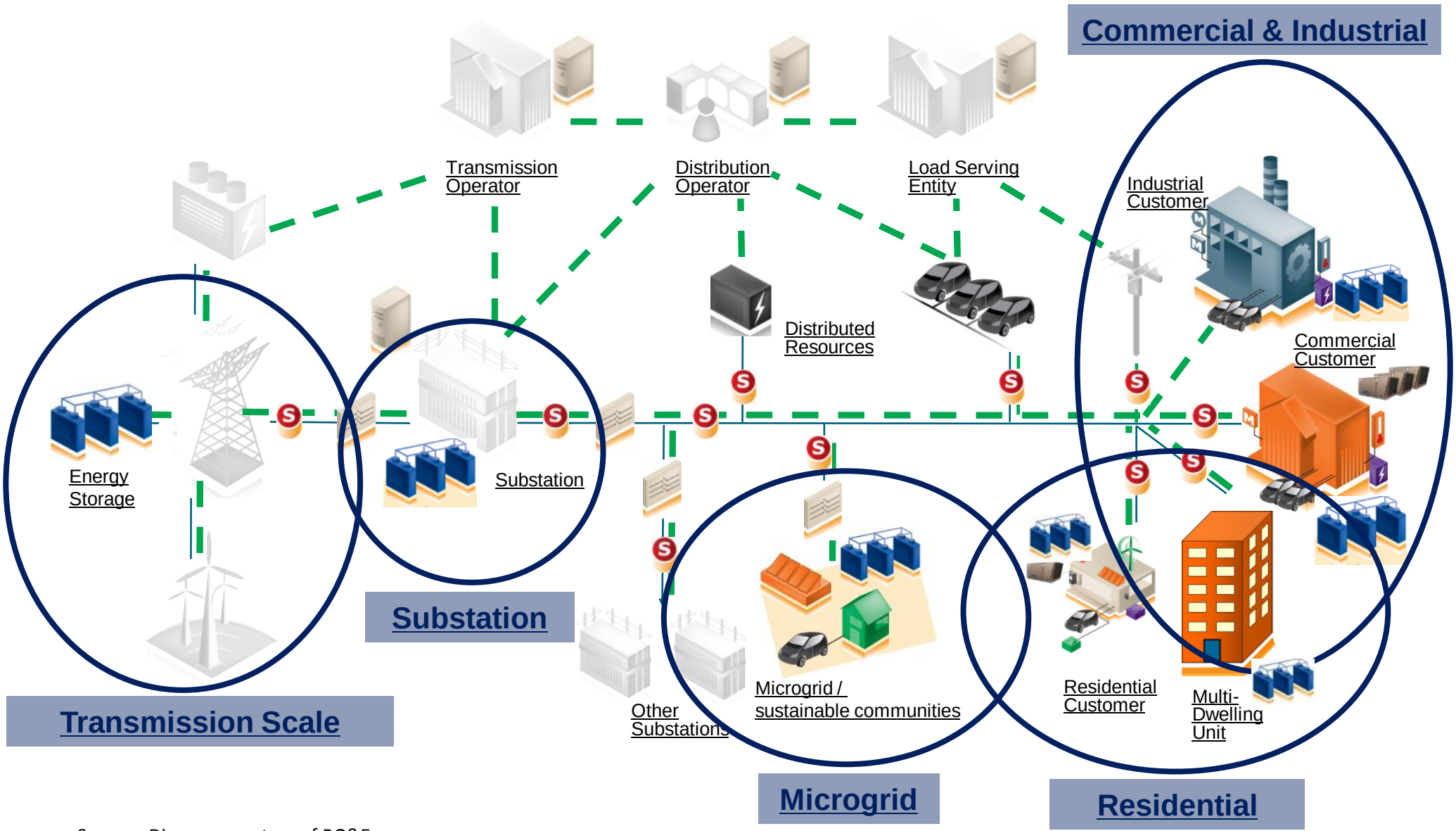
Storage is a Necessary Component of Smart Grid



Source: Diagram courtesy of PG&E

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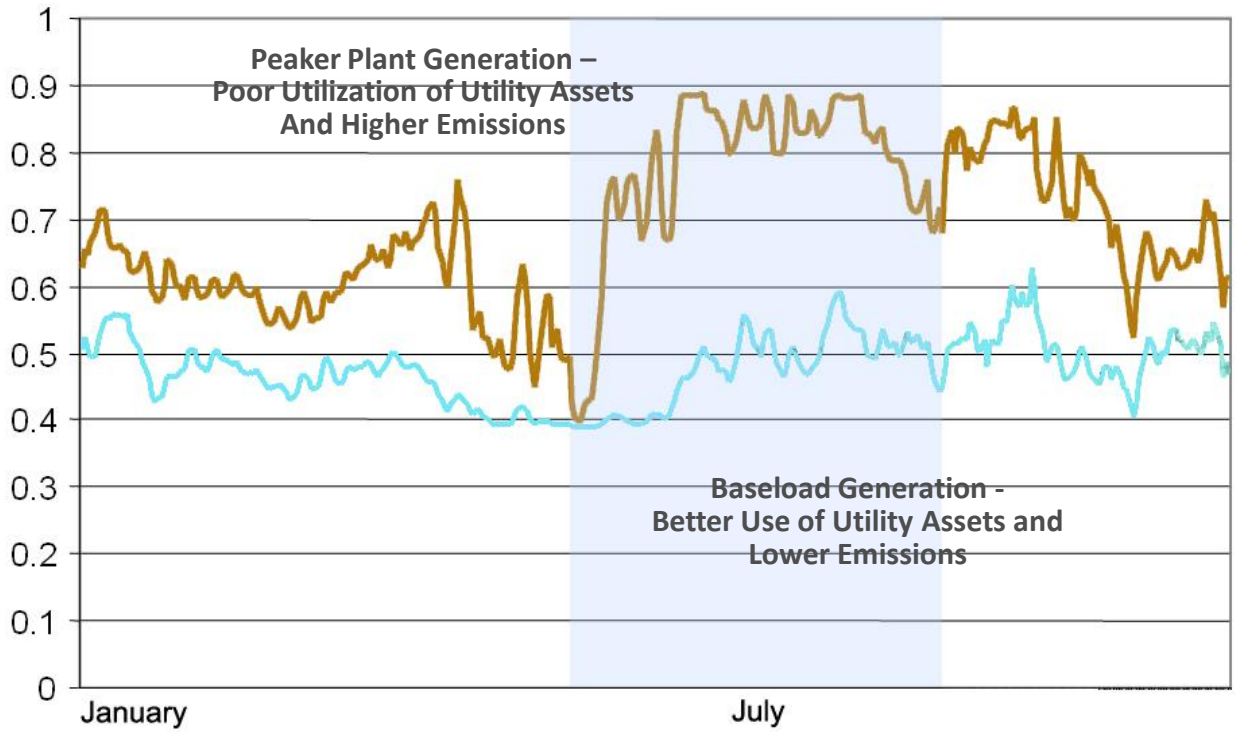
Another Key Driver: Storage Reduces GHG Emissions

- 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

Peak vs. Off-peak CO_2 Emission Rate (Tons/MWh)



1) Source: Southern California Edison

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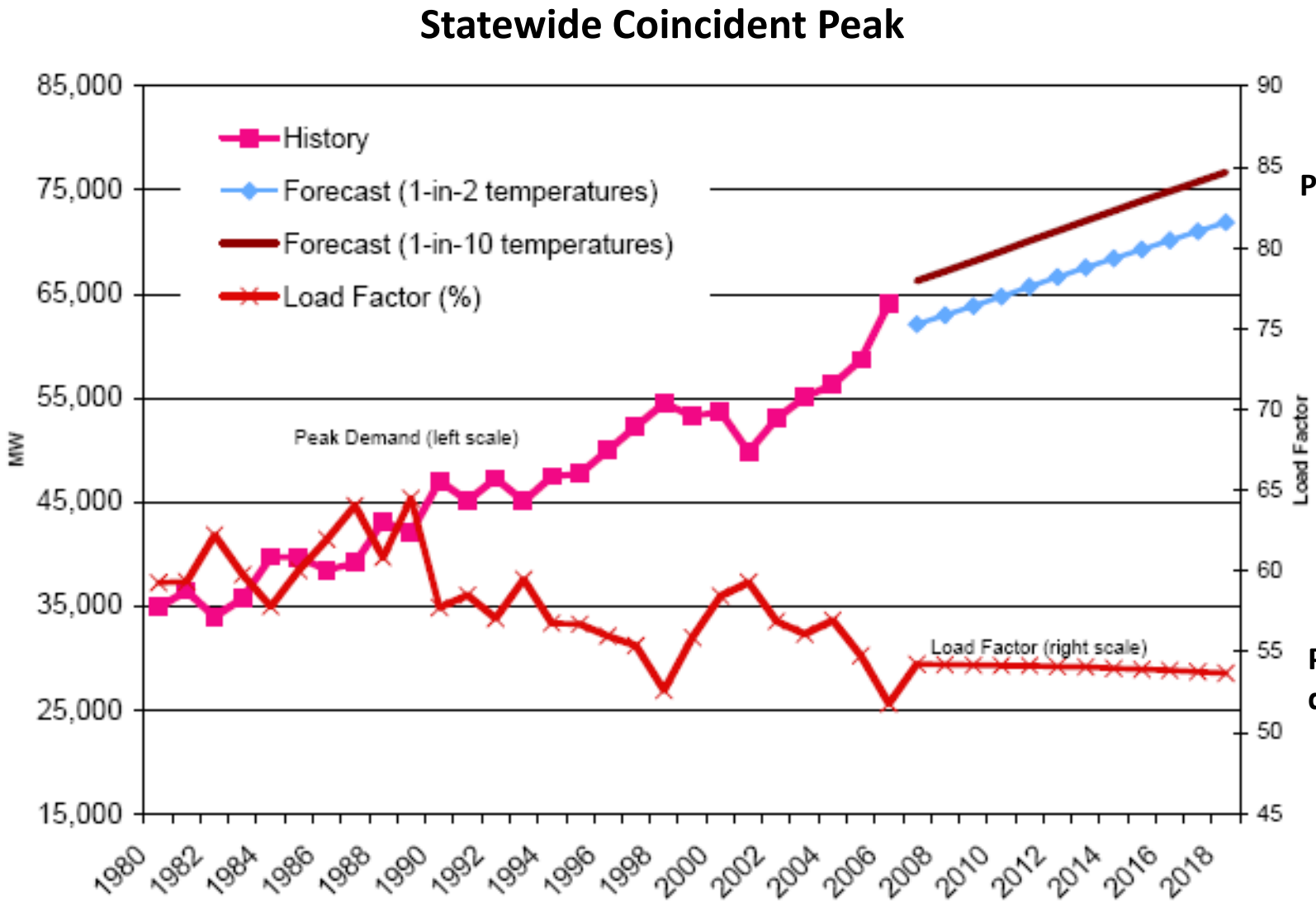
Peak Has Been Growing & Asset Utilization Decreasing



Peak demand grows

Power plant utilization declines

Source: California Energy Commission California Energy Demand 2008–2018, CEC-200-2007-015-SF
Note: near term demand may decrease due to recession

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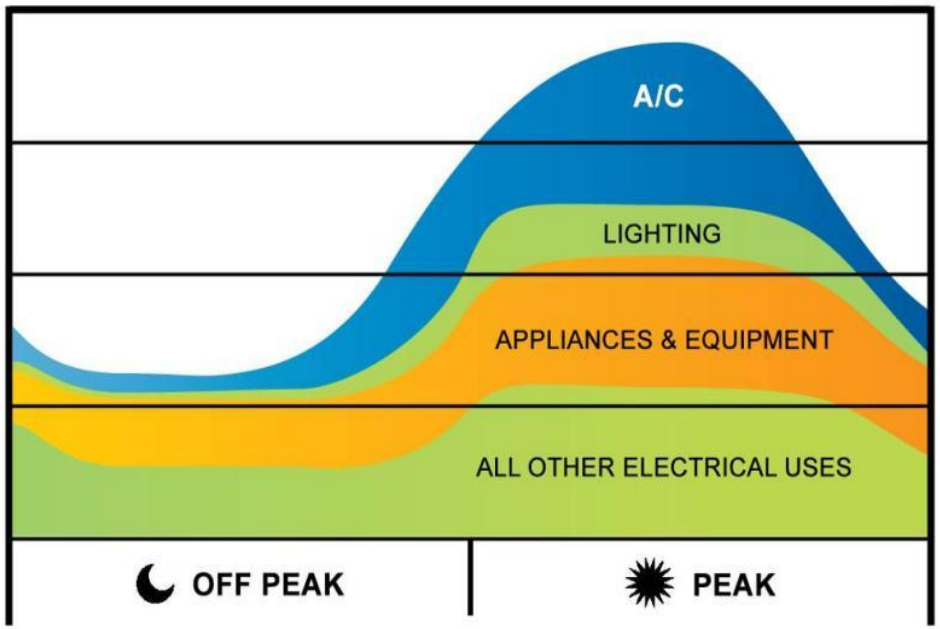
Storage can Permanently Shift Load Away From Peak Hours and Optimize our Existing T&D System

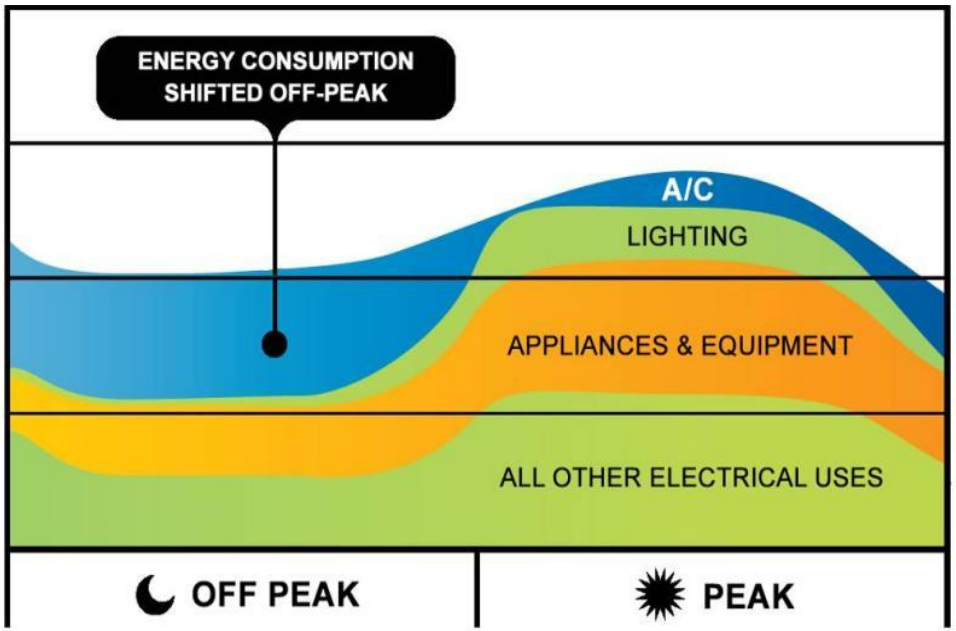
- Energy storage can dampen the volatility of energy demand
  - Reduces T&D losses by as much as 50%
  - Reduces congestion and optimizes grid utilization
  - Reduces CO_2 and NO_x by utilizing better heat rate resources
  - Efficiently stores off-peak wind

Typical 24 hour load profile



Low Capacity Factor

With energy storage (thermal example)



High Capacity Factor

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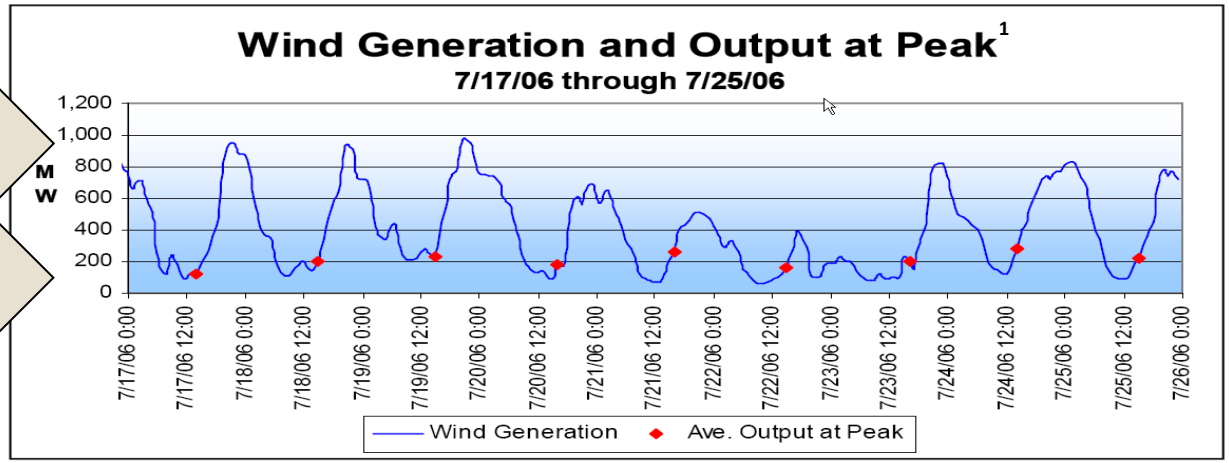
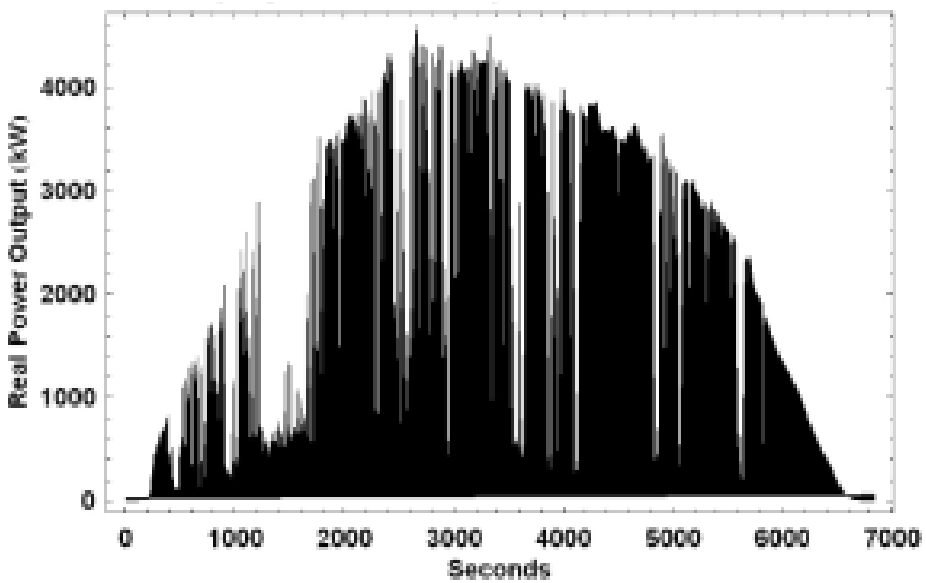
Storage will Bolster Variable Wind and Solar Resources

output

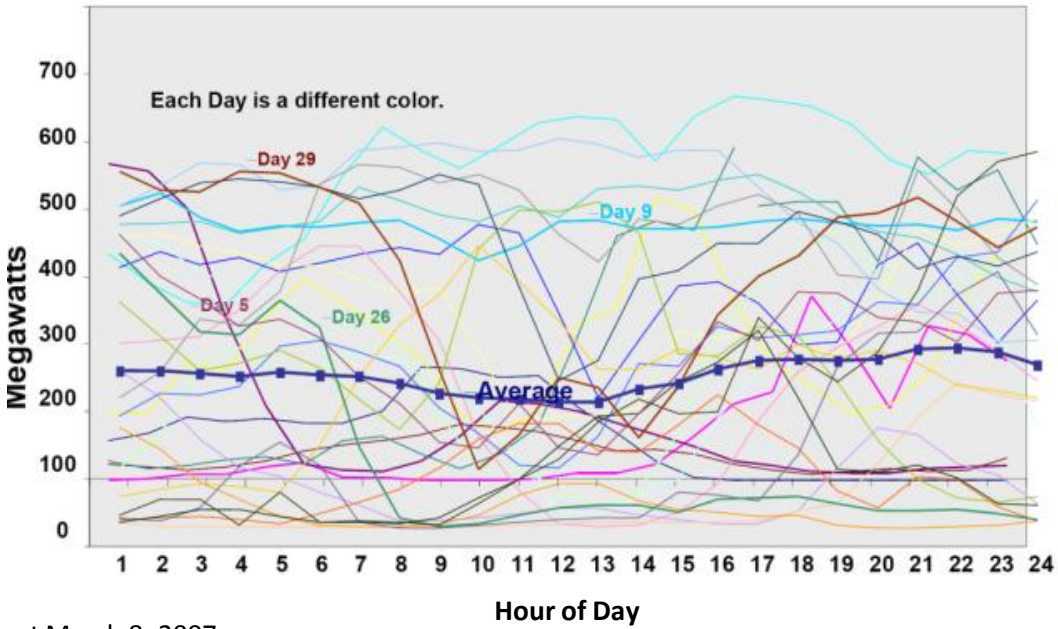
demand



Springerville, AZ, One Day at 10 Second Resolution [2]



One Month's Power from a Wind Farm[3]



1) Source: CAISO 2007 Summer Loads and Resources Operations Assessment March 8, 2007
2) Source: Integration of Renewable Resources, CAISO Report, November 2007
3) Source: Jay Apt and Aimee Curtright, Carnegie Mellon Electricity Industry Center working Paper CEIC-08-04

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Experts Agree: Storage Aids Renewable Integration

"Enabling technologies such as fuel switching in 'smart' appliances, dispatch-able load from plug-in hybrid or other electric vehicles, or stationary energy storage would be required to enable very high levels of PV contribution (>20%) to the electric power system".

- NREL Denholm & Margolis, April 2006

"When PV penetration reaches sufficiently high levels (e.g., 5 to 20% of total generation), the intermittent nature of PV can begin to have noticeable, negative effects on the entire grid" [requiring storage]

- US DOE, SEGIS-ES, July 2008

"Storage will need to be part of our portfolio if going to 15 to 20 percent wind at a national level, otherwise it won't be efficient at a lower level and it won't get us where we want to go environmentally"

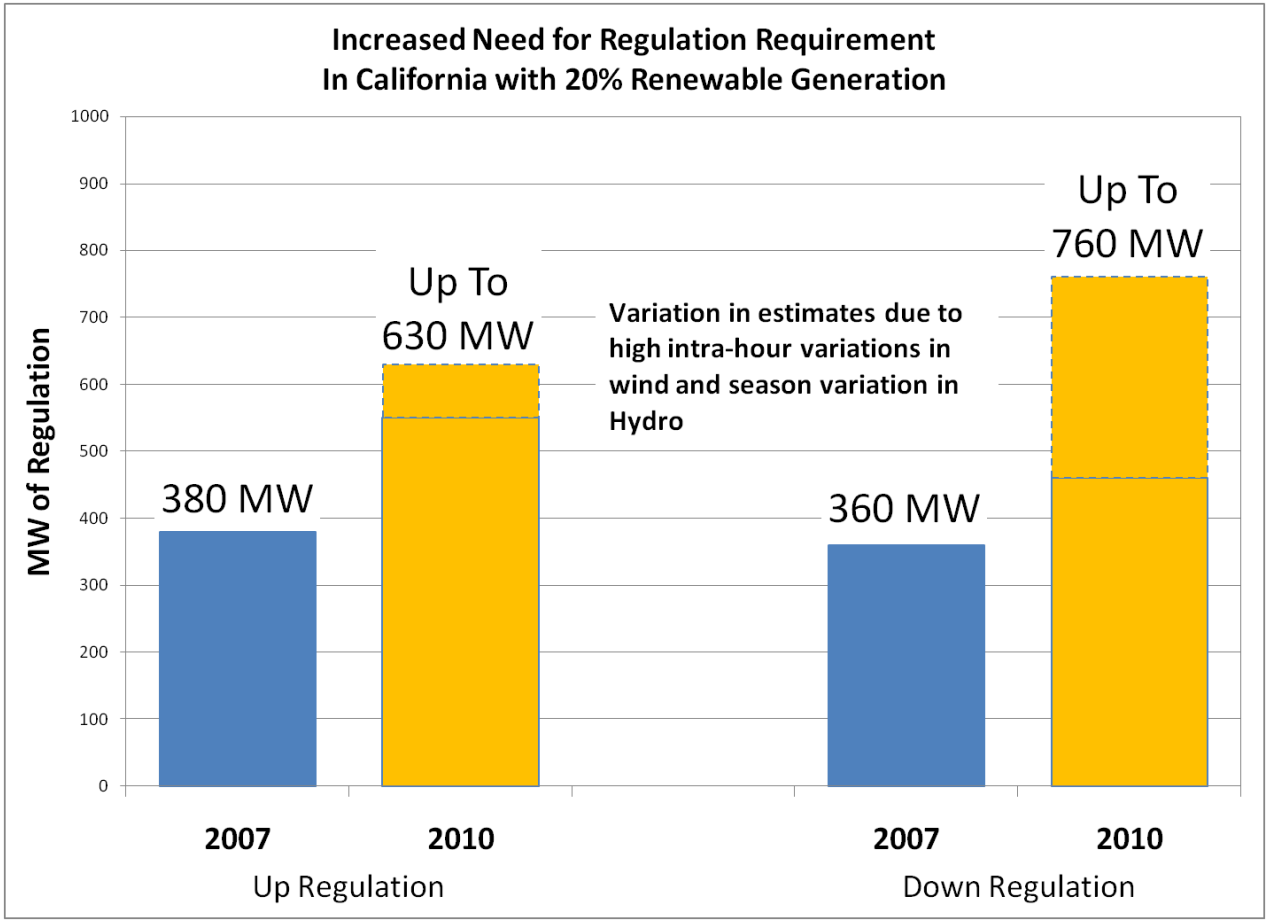
- Electric Power Research Institute, March 2009

"Fast response technologies can reduce the amount of regulation procurement required – Up to 40% in CAISO"

-Pacific Northwest National Lab, June 2008

Storage can address increased need for power regulation and ramping due to CA's RPS

- 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

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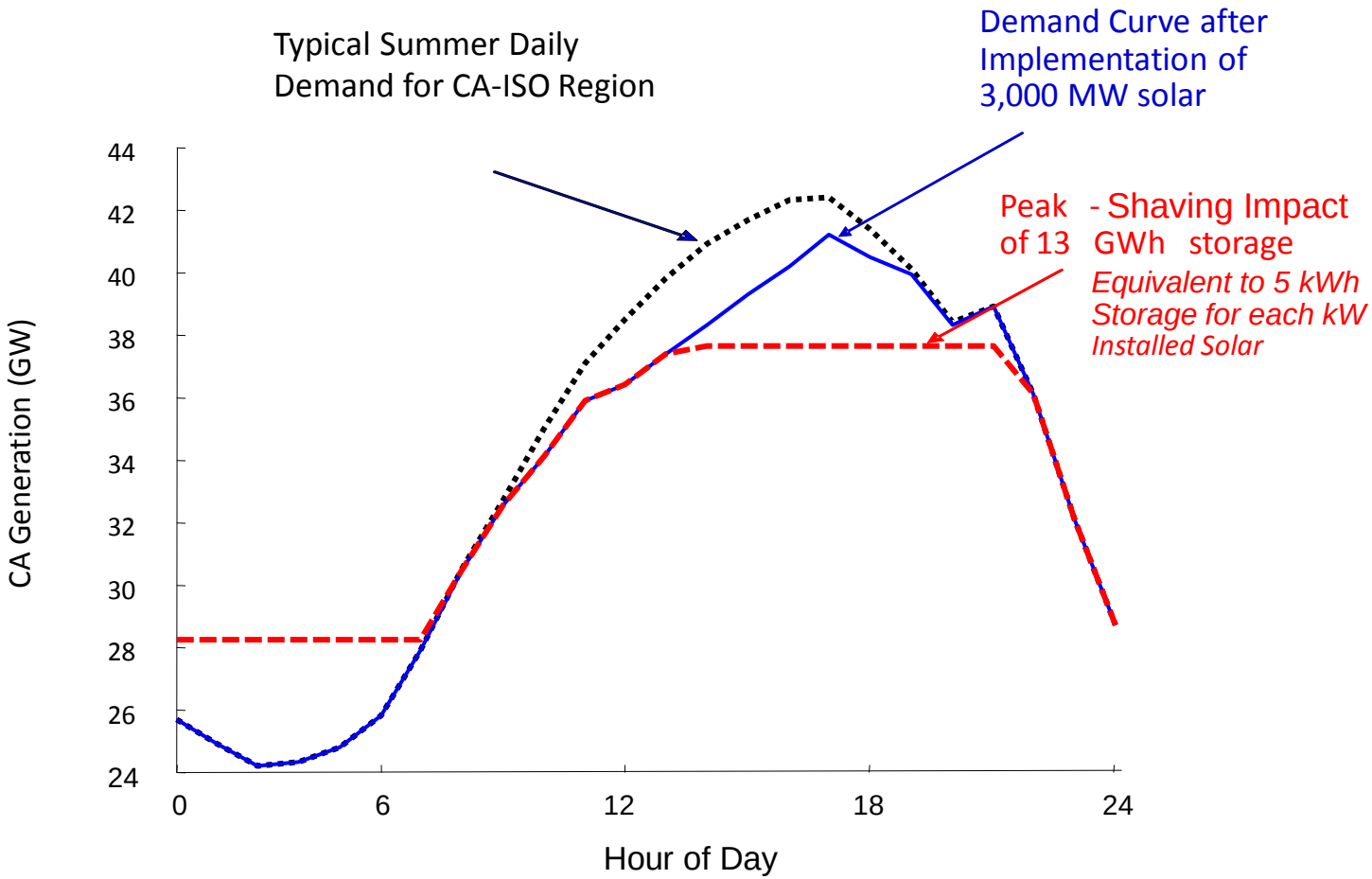
Storage can shave peak demand synergistically with renewables … solar example

The chart below demonstrates how distributed energy storage – particularly when paired with renewables – can have a significant load shaving impact



Source: EPRI

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Energy Storage Enables Multiple Value Streams

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

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!

Policy Intervention is Needed – AB 2514 is the Answer

1. Current California policy has not kept pace with advances in energy storage
2. California faces many complex and inter-related energy policy challenges that can be addressed by energy storage
   - GHG reduction
   - Integrating renewable energy
   - Grappling with transmission and distribution constraints
   - Growing peak demand
   - Accommodating electric vehicles
   - Incorporating real time pricing
3. Policy intervention will help capture storage's many benefits for ratepayers
4. AB 2514 provides the necessary leadership and focus to realize storage's many benefits ….Now!
5. AB 2514 will ensure that California capitalizes on the tremendous global economic development opportunity provided by grid connected storage

California can seize this opportunity or watch it go by

AB 2514 – Landmark New Storage Legislation

AB 2514 requires procurement of new storage capacity

- Would establish **Energy Storage Procurement Targets for 2015 and 2020**
- Sponsored by Jerry Brown, California Attorney General
- Authored by Assembly member Nancy Skinner, Chair, Assembly Rules Committee
- Mandate for California utilities to procure new energy storage representing:
  - CPUC to set MW procurement targets by 10/1/13 for 2015 and 2020
  - All cost-effective forms of energy storage are eligible
  - All applications are eligible – especially to facilitate renewables
  - Utility owned, customer owned, and third party owned are eligible
  - Penalties for non compliance
- Status – last amended 4/28/10
  - Passed Assembly Utilities and Commerce Committee hearing 4/22/10
  - Passed Assembly Natural Resources Committee hearing 4/22/10
  - Passed Assembly Appropriations Committee 5/28/10

CESA is working closely with all stakeholders

50 Companies and Organizations Support AB 2514*

1. California Attorney General's Office
2. A123 Systems
3. Applied Intellectual Capital
4. Altairnano
5. Beacon Power
6. Breathe California
7. CALMAC
8. CA Wind Energy Association (CalWEA)
9. CA Energy Storage Alliance (CESA)
10. CAREBS
11. Clean Power Campaign (CEERT)
12. Debenham Energy
13. Deeya Energy
14. Dow Kokam
15. Electricity Storage Association (ESA)
16. ElectronVault
17. EnerSys
18. EnerVault
19. Environmental Defense Fund (EDF)
20. FAFCO
21. Fluidic Energy
22. HDR|DTA
23. Ice Energy
24. Independent Energy Producers
25. Large-Scale Solar Alliance
26. LightSail Energy
27. Megawatt Storage Farms
28. MEMC
29. Mohr Davidow Ventures
30. Natgun
31. NGK-Locke
32. Pacific Environment
33. Panasonic
34. Pearl Street Liquidity Advisors
35. Polaris Venture Partners
36. PowerGenix
37. Prudent Energy
38. PVT Solar
39. Rockport Capital Partners
40. SAIL Venture Partners
41. Samsung SDI
42. SANYO
43. SEEO
44. Sierra Club
45. The Solar Alliance
46. Suntech
47. SustainX
48. Union of Concerned Scientists
49. The Vote Solar Initiative
50. Xtreme Power

* As of June 22, 2010. Organizations highlighted in green are primarily environmental or renewable energy organizations

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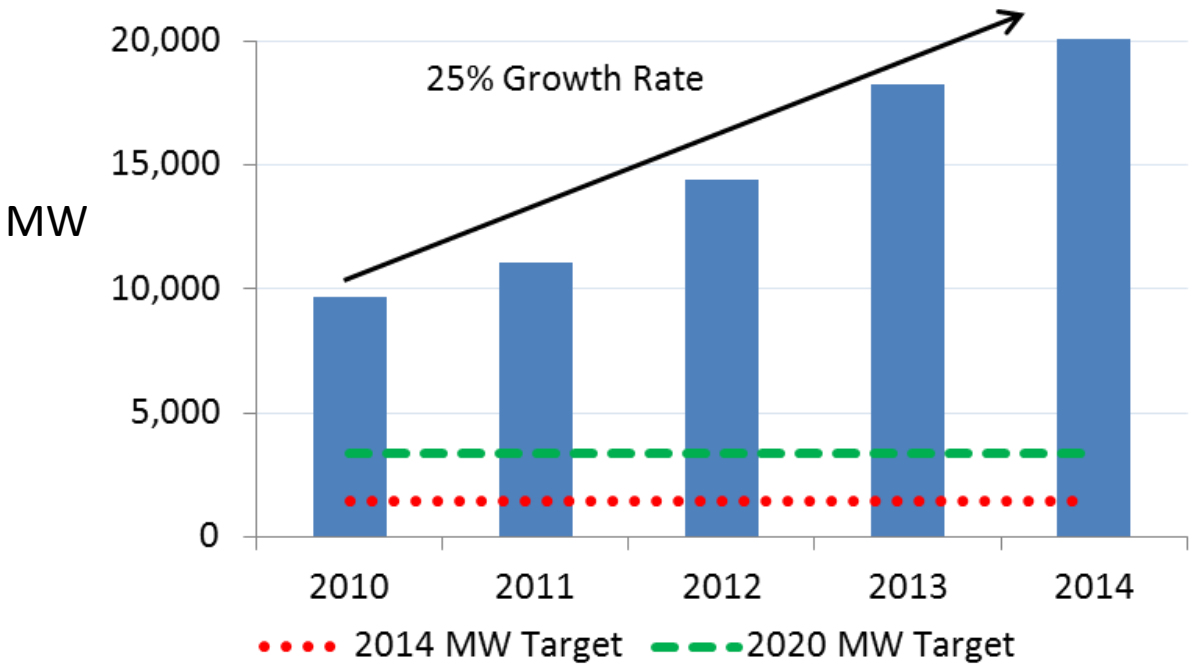
AB 2514 targets are achievable … Based on manufacturing capacity survey of 22 Companies

The energy storage industry can easily meet the goals of AB 2514, and in so doing, create thousands of new permanent jobs in California

Energy Storage Manufacturing Capacity



Conclusions

- **85%** of companies surveyed will consider establishing manufacturing capacity in California if AB 2514 becomes law
- This would create **+5,500** new permanent jobs
- **6.7x** of the 2014 MW goal is available from manufacturers today
- Planned 2014 capacity is **7.0x** of the 2020 goal
- Multiple individual firms could meet the AB 2514 goals on their own.

Source: StrateGen Consulting, LLC Industry Survey, Rev. 1, 3/23/2010. Survey respondents: A123 Systems, Altairnano, Beacon Power, CALMAC, Deeya, ElectronVault, EnerVault, Evapco, FAFCO, Fluidic Energy, Ice Energy, NGK-Locke, Panasonic, Powergetics, Prudent Energy, PVT Solar, Samsung, Sanyo, Seeo, SustainX, Velkess, Xtreme Power

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AB 2514 is achievable… Based on existing grid storage projects being commercialized today

- Over 2GW of advanced energy storage are already installed worldwide
- Sodium sulfur battery projects are being built overseas in +100 MW increments
  - 300 MW NAS installation in Abu Dhabi
  - 150 MW NAS installation in France (EDF)
- Beacon Power has three 20 MW flywheel storage projects for frequency regulation in various stages of development
  - 20 MW Flywheel plant in Stephentown NY – under construction
  - 20 MW Flywheel plant in Chicago IL – planned
  - 20 MW Flywheel planned in Glenville NY – interconnection application filed
- Ice Energy and Southern California Public Power Authority contracted for 53 MW of distributed thermal storage in January 2010
  - Largest aggregated distributed storage project ever
  - 53 MW of distributed storage is ~ 1%-3% of participating utilities' peak demand
  - To be installed within two years
- Altairnano currently operating in the PJM Control area in a frequency regulation mode

Storage is Cost Effective Today!

- Beacon Power's flywheel plants are developed on merchant basis
  - Plants participate in existing frequency regulation markets
  - Plants do not use fossil fuels and are able to achieve high gross margins on operations
  - Plants will meet minimum internal rate of return required of such investments
  - Plants emit zero emissions
- Thermal storage is widely deployed today worldwide
  - 142 MW of molten salt thermal storage deployed outside the US
  - SCPPA member utilities found thermal storage to be cost effective
  - Calmac's thermal ice storage products are installed in thousands of customers in more than 30 countries around the world
- Many new storage technologies are being commercialized with dramatically lower cost, addressing new applications of storage, examples include:
  - Advanced lead acid batteries
  - Metal air batteries
  - Modular compressed air

Energy storage is 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

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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)

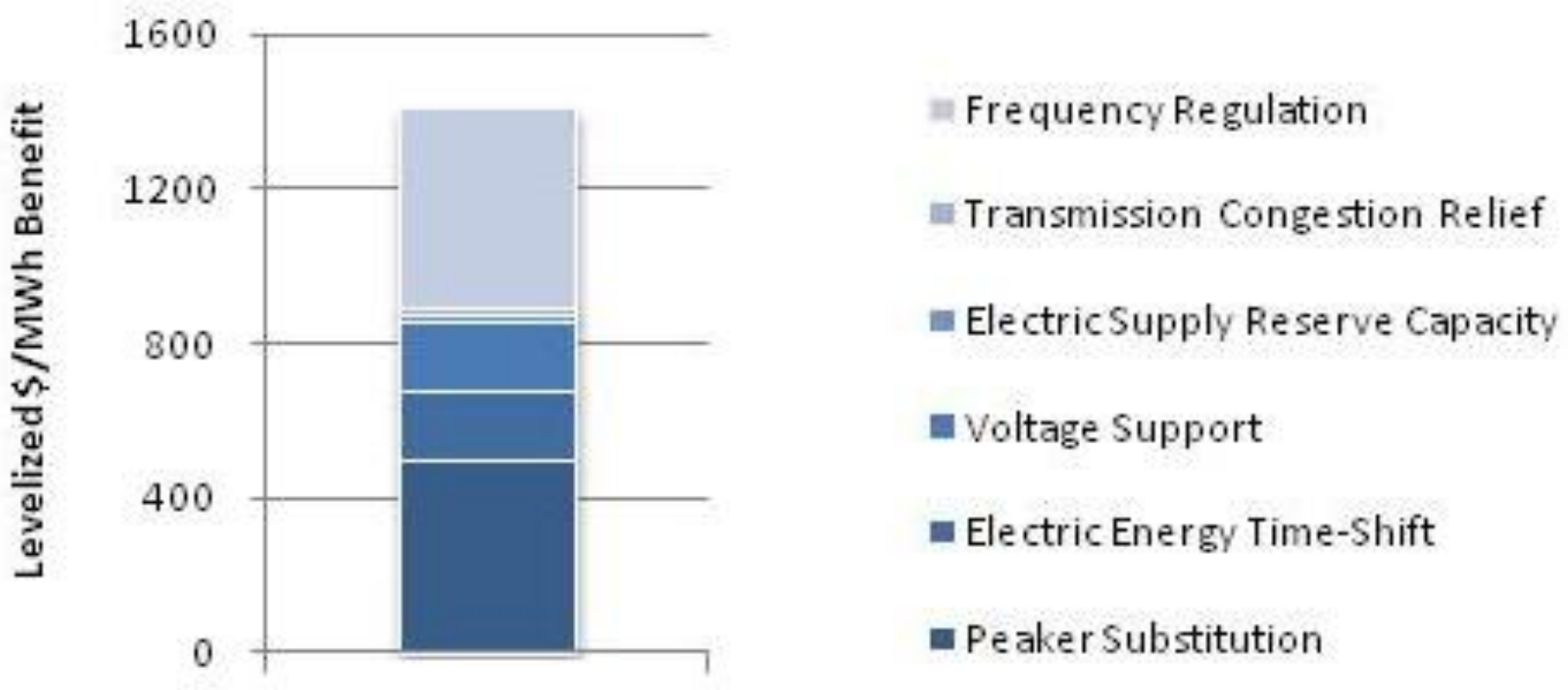
Costs	Assumptions	LCOG ($/MWh)	LCOG ($/kW-yr)
Fixed O&M	$6/kW/yr	$17	$7
Corp. Taxes	0%	$0	$0
Insurance	0.6% of CAPEX	$22	$9
Property Tax	1.1% of CAPEX	$28	$12
Off-Peak Grid Charging	$24/MWh[3]	$48	$20
Variable O&M	$0.04/kWh	$5	$2
Subtotal		$121	$50

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)

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)

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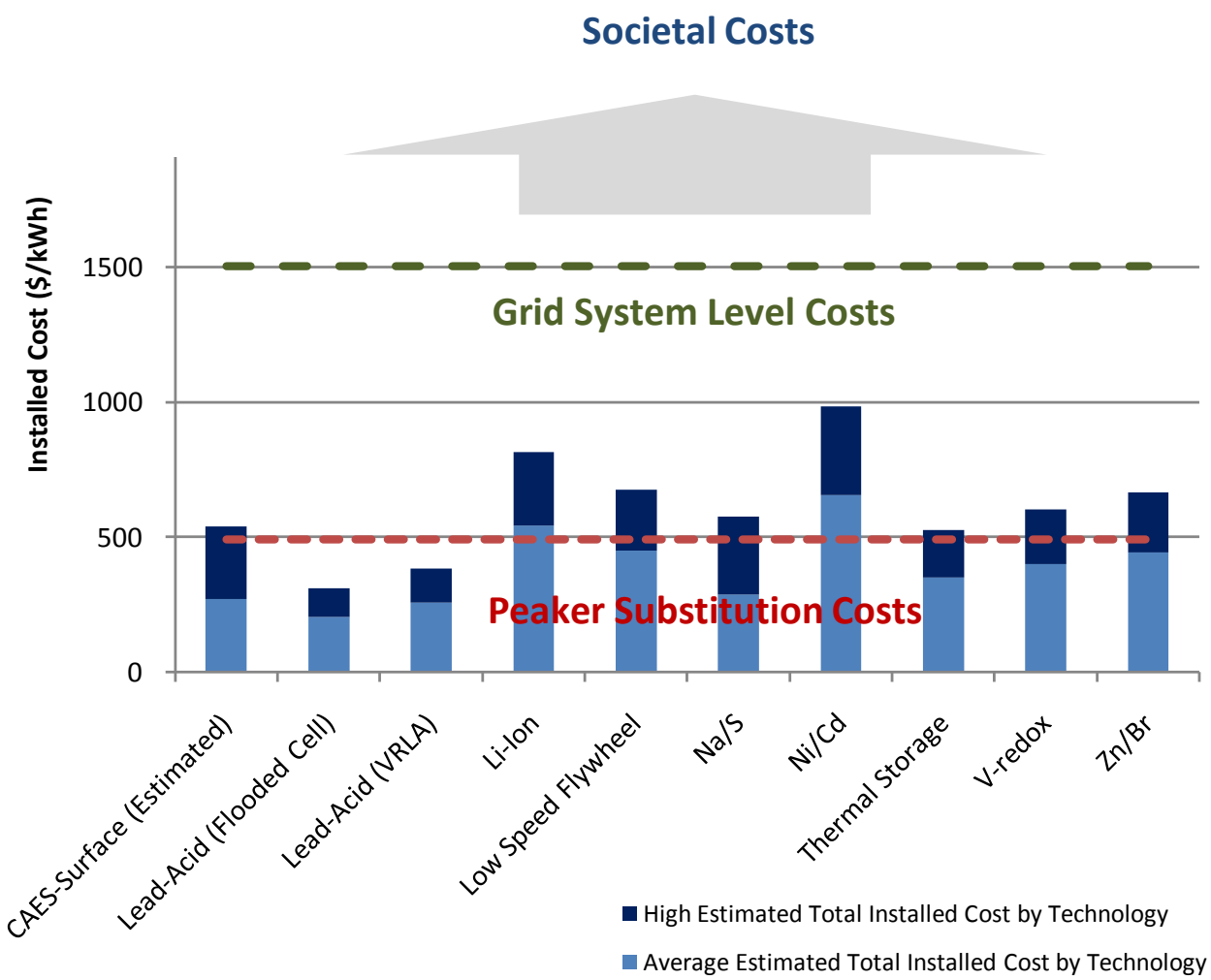
Energy storage is a cheaper and cleaner alternative to natural gas peakers – additional benefits of storage

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)

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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

Summary

Grid storage will be a key enabler of California's many energy policy goals

- Energy storage is fundamental to many key California energy policy initiatives
- Grid storage market is large and growing fast
- Energy storage enables many value streams, but requires government intervention to align benefits with costs
- Energy storage is already considered an eligible subset of demand response, onsite generation, ancillary services and the smart grid
- However, as an 'eligible subset', energy storage suffers as it is not a priority of any of these areas – resulting in incorrect market structure and underinvestment
- Energy storage enables compelling economic and environmental benefits and is deserving of greater focus to realize these benefits

AB 2514 provides the necessary leadership to realize the benefits of energy storage now!

For additional questions, please contact:

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Janice Lin | CESA Co-Founder and Managing Partner of StrateGen Consulting

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Appendix

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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

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 enable CA to achieve a RPS of 33% by 2020
4. Energy Storage is a key component of CA's smart grid goals

Global Installed & Announced Energy Storage

Energy Storage Installed Capacity (MW)

Technology	CA	Rest of USA	Rest of World	Totals
Batteries	19	44	388	451
Compressed Air	-	110	330	440
Molten Salt	-	-	142	142
Other	2	75	18	95
Pumped Hydro	3,850	19,862	99,678	123,390
Thermal	2	668	332	1,002
Total	3,872	20,760	100,888	125,520
Total minus Hydro	22	898	1,210	2,129

Energy Storage Announced Capacity (MW)

Technology	CA	Rest of USA	Rest of World	Totals
Batteries	45	89	450	584
Compressed Air	300	421	-	721
Molten Salt	143	361	479	982
Other	-	80	-	80
Pumped Hydro	3,410	-	42,908	46,318
Thermal	56	-	-	56
Total	3,953	951	43,837	48,741
Total minus Hydro	543	951	929	2,423

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.

Projects Announced in CA

Technology	Location	Date Announced	Utility	Vendor	Power (MW)	References
Li Ion	Irvine, California	2009	Southern California Edison	A123		DOE FOA 36 Award
Pumped Hydro	Riverside, California	2008	Eagle Mountain	Eagle Crest Energy	1,300	HydroReview magazine, July 2009 edition, Eagle Mountain Energy
Pumped Hydro	Tuolumne, California	2009	Modesto & Turlock Irrigation Districts		880	HydroReview magazine, July 2009 edition
Pumped Hydro	Riverside, California	2009	Several		500	HydroReview magazine, July 2009 edition
Pumped Hydro	Iowa Hill, California	2009	Sacramento Municipal Utility District (SM		400	Sacramento Municipal Utility District (SMUD)
CAES	Kern County, California	2009	PG&E		300	Next 100 Article
Pumped Hydro	Alameda, California	2009	Brookfield Renewable Power		280	HydroReview magazine, July 2009 edition
Thermal	California	2010	Southern California Public Power	Ice Energy	53	Ice Energy Press Release
Pumped Hydro	San Diego, California	2009	San Diego County Water Authority		50	HydroReview magazine, July 2009 edition
Li Ion	Tehachapi, California	2009	Southern California Edison	A123	8	DOE FOA 36 Award, Tehachapi Wind Integration, 2011 deployment
NAS	San Jose, California	2009	PG&E		4	CEC press release
Flow	Sacramento, California	2009	SMUD	Premium Power	4	
Molten Salt	Rice, California	2009	PG&E	Solar Reserve	143	New York Times article
Flow	California	2010	PG&E	ZBB	2	Blog w/ access to good data (Platts)
Flow	Alameda, California	2009	Modesto Irrigation District	Primus Power	25	Sandia Press Release
Li Ion	Berkeley, California	2009		Seeo		Sandia Press Release
Flywheels	Fremont, California	2009		Amber Kinetics		Sandia Press Release
Thermal	Glendale, California	2009	Glendale Water & Power	Ice Energy	1500	Ice Energy Press Release
Total					5,448	

Source: StrateGen Consulting, LLC. Confidential projects excluded. Figures current as of April, 2010.