PANEL 3: Utilities' Perspective of Energy Storage

Mark Rawson
Sacramento Municipal Utility District

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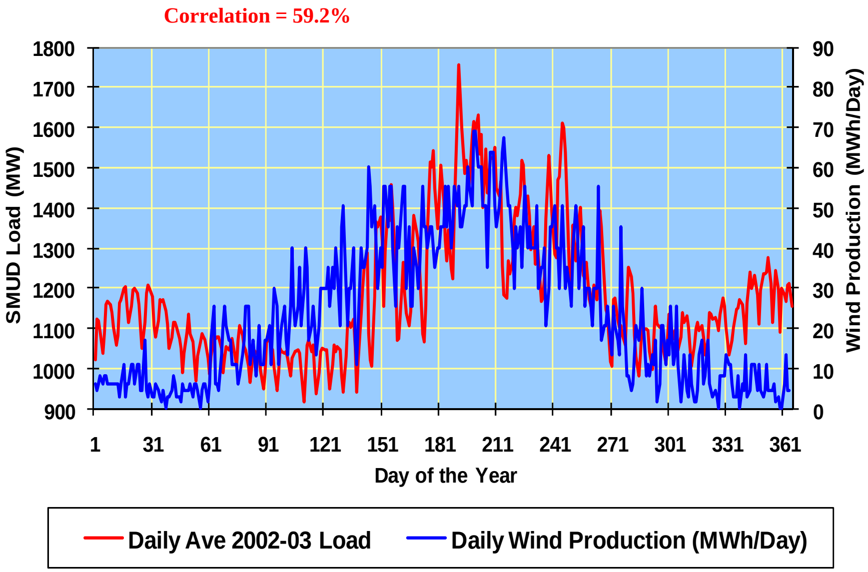
Panel Questions

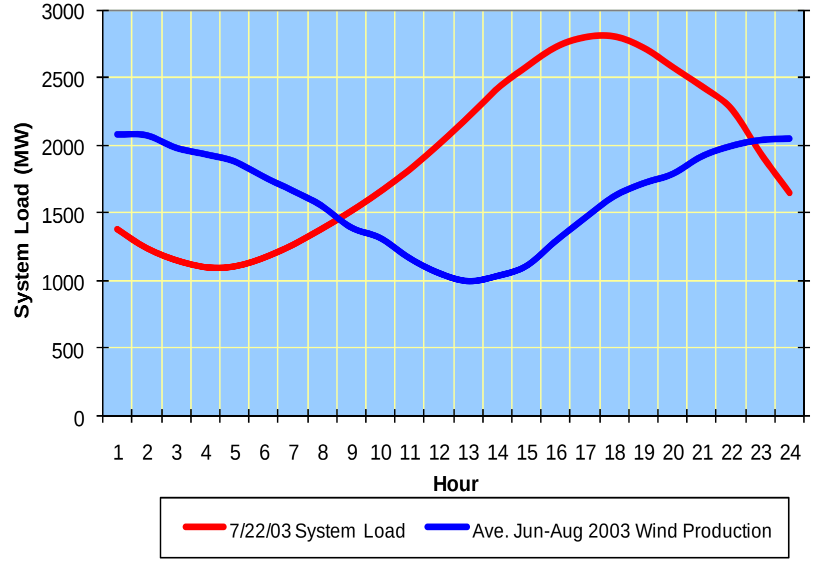
- *How does the role of energy storage differ from the utility or market perspective?*
- *Who should own grid connected energy storage?*
- *How will the utilities implement the Energy Storage development, demonstration and deployment plan for meeting the AB 2514 requirements?*

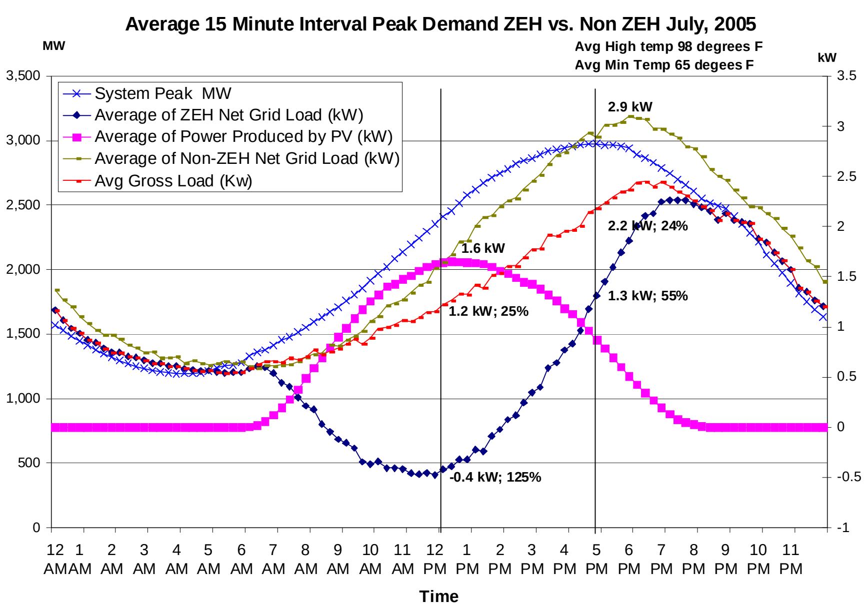
What Is Driving SMUD's Storage Interest?

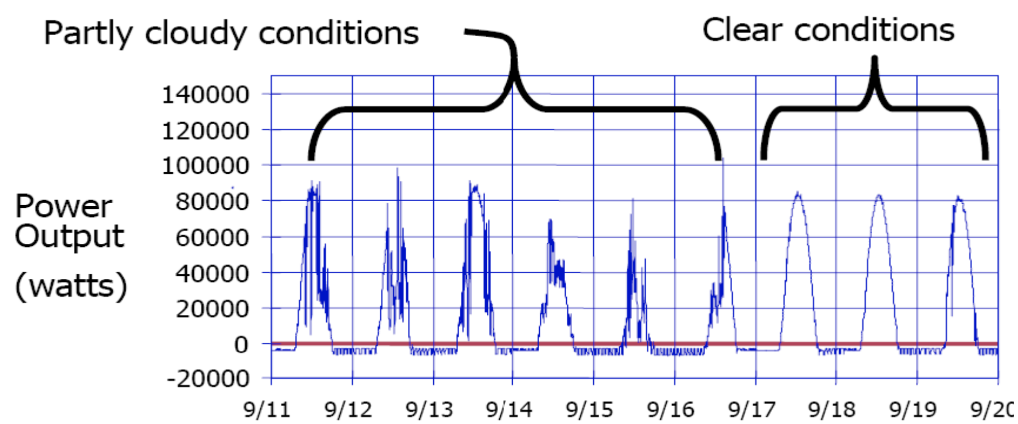
- GHG Regulations
  - SMUD Sustainable Energy Goal (90% reduction by 2050)
  - Reshaping Energy Supply
  - Prompting PHEV Development
- RPS-driven Wind And Solar Energy Additions
  - Wind—weak Forecasting, Large Ramps, Unpredictable Production During Super Peaks
  - Solar—peaks 4-5 Hours Before Utility Peak, Large Ramps
- Peak Load Management

SMUD Renewable Generation – Storage As A Mitigation Strategy?









SMUD's Storage Approach

- Believe SMUD will need bulk **and** distributed storage in long run
- Questions of what kind, how much of it and when, and how much will it cost
- Pursuing a multi-pronged approach:
  - Developing improved understanding of storage technologies
  - Anticipate starting preliminary design on bulk storage project in 2011
  - Determining the benefits of distributed storage to SMUD
    - Modeling and analytical work – assess the value of different storage technologies deployed at high value sites on the T&D system
  - Conducting distributed storage system demonstrations and monitoring performance
  - Preparing SMUD for energy storage utilization - AB 2514 planning and execution

Variety of Potential Applications and Benefits

Utility Grid Benefits

- Load Shifting; Peak Reduction
- Increased Load Serving Capability
- Regulation Services (Frequency, Load/ Generation Balance)
- Spinning Reserves
- Mitigate T&D Congestion
- Reduce T&D losses
- Network Stability
- Voltage Support; Control
- VAR Support; Control
- Firming Intermittent Renewables
- Mitigate Need for Wind Curtailment/Turndown
- Market Price Arbitrage
- T&D Deferment
- New Generation Deferment
- CAISO Access Charge Reduction

Customer-Side Benefits

- Electricity Arbitrage; Buy Low, Sell High
- Peak Shifting; Avoid Peak Rates; Demand Charge Reduction
- Enhanced Reliability
- Improved Power Quality

Both:

- **Not all benefits are mutually exclusive**
- **Some applications benefit both utility and customer**

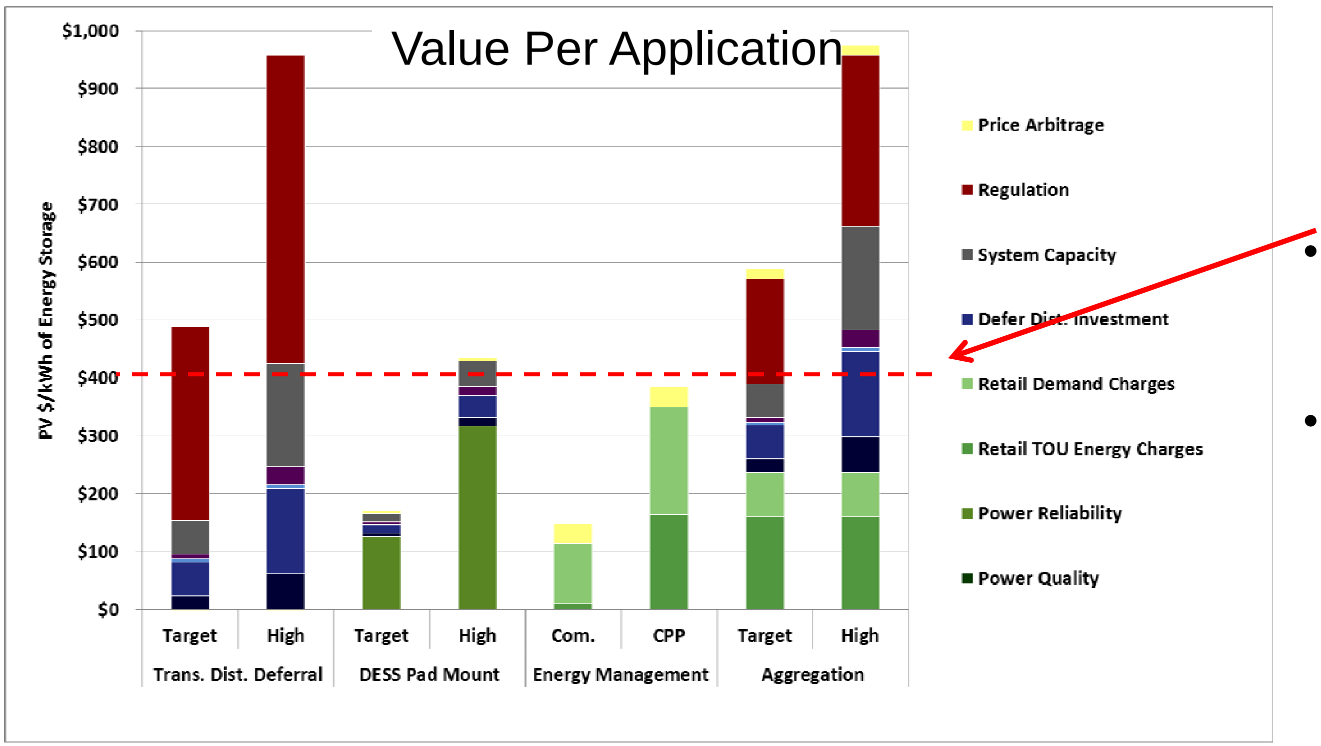
Question:

- **How do we quantify these benefits under different storage deployment scenarios (e.g., ownership structures)?**

Adapted from: Energy Storage Benefits and Market Analysis Handbook, Sandia National Laboratory, December 2004

Value of Storage for SMUD

- Graphic summarizes present value of different storage applications
  - Transportable storage used to defer distribution investments
  - Distributed energy storage (DESS) installed adjacent to distribution transformers
  - Commercial customer sited storage used to reduce energy costs and demand charges
  - Residential and commercial customer sited storage aggregated by a 3rd Party with value sold to utility



Source: Energy Storage Benefits for SMUD, EPRI/E3, October 2010

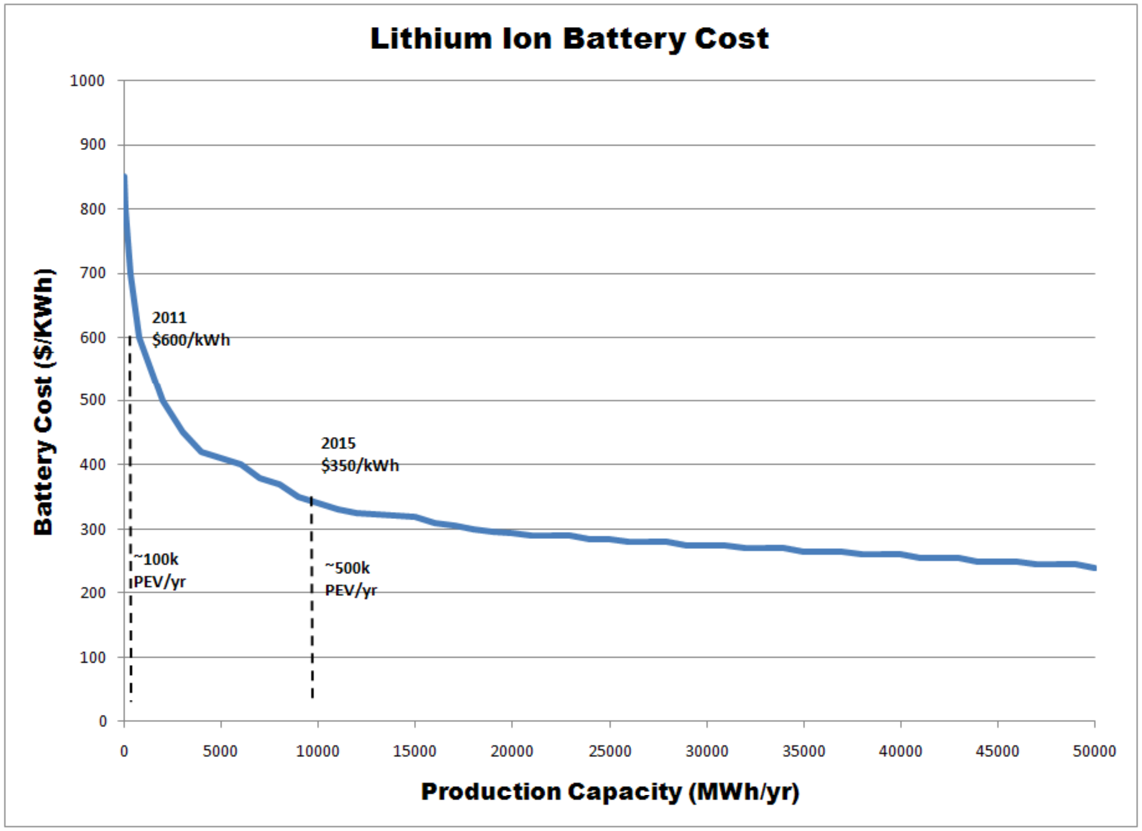
- Results — some storage systems could be cost effective for SMUD and SMUD customers at $400/kW-h price point
- Current zinc-bromine flow battery system is within this cost today
- Today though, storage systems remain unproven for life, durability, reliability and cost
  - ➢Current R&D projects are addressing these uncertainties

Recommendations

- CEC IEPR can provide clarity to interpretation of AB 2514 – what's in and what's out
  - Building pre-cooling as a Demand Response strategy?
  - Saving CHP waste heat as chilled or hot water for space conditioning?
  - Molten salt thermal energy storage with CSP?
- Retain flexibility
  - Allow multiple ownership structures so incentives can be leveraged - e.g., investment tax credits
  - Allow utilities flexibility to pursue bulk storage, distributed storage or both as their needs dictate
  - Focus on cost effectiveness of benefits delivered
    - Shouldn't be pursuing storage for storage's sake
    - Pursuing value it provides
    - Other technologies like renewables, efficiency and load control may provide like value more cost effectively

Additional Information

Expected Cost Reductions For Li^+



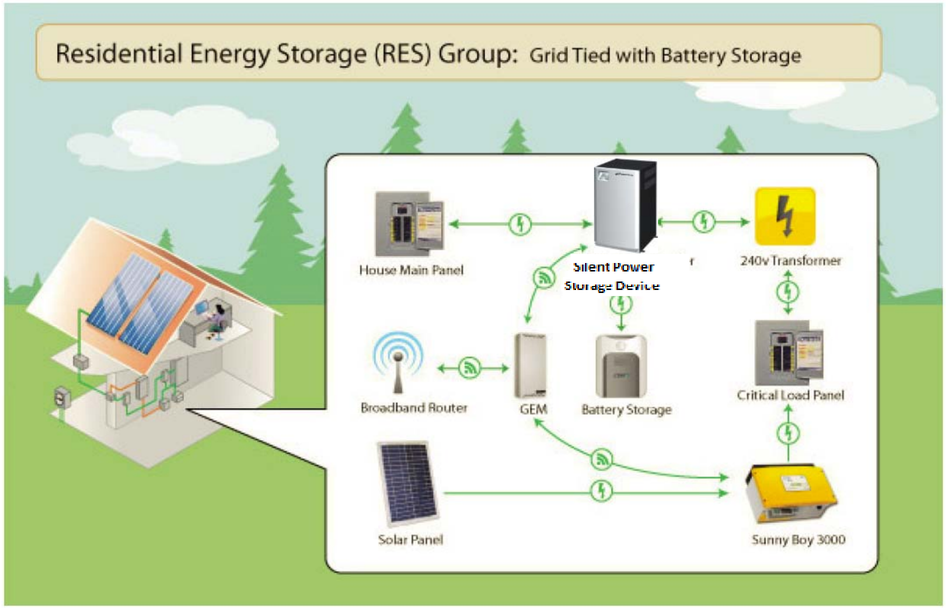
Note: Best fit curve for a family of Li-ion cost projections, including ANL (2009), EPRI (2007), Miller (2006), CARB (2007), and TIAX (2009)

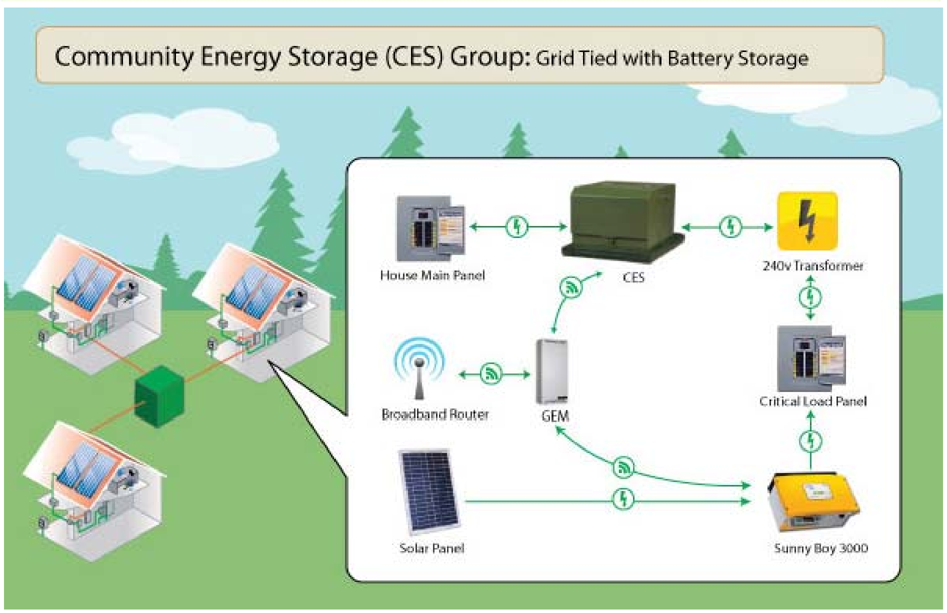
- Source: **Lithium-ion Energy Storage Market Opportunities,** *Application Value Analysis and Technology Gap Assessment,* **EPRI Publication Number 1020074**
- Production of 1,000 MWh of PEV batteries per year would result in $600/kW-h (100,000 vehicles assuming 20kW-h per battery; $12,000 PEV battery pack)
- Production of 10,000 MWh of PEV batteries per year would result in $350/kW-h (500,000 vehicles; $7,000 PEV battery pack)

- Cost estimates in-line with projections provided to EPRI by leading Li-ion battery vendors for 2011 and 2015
- Future stationary applications for lithium-ion can be on order of $400/kW-h (includes balance of plant costs for power electronics and utility interconnection)

SMUD PV & Smart Grid Pilot at Anatolia

ARRA FOA 85 High Penetration Solar Development (DOE Award DE-EE0002066)

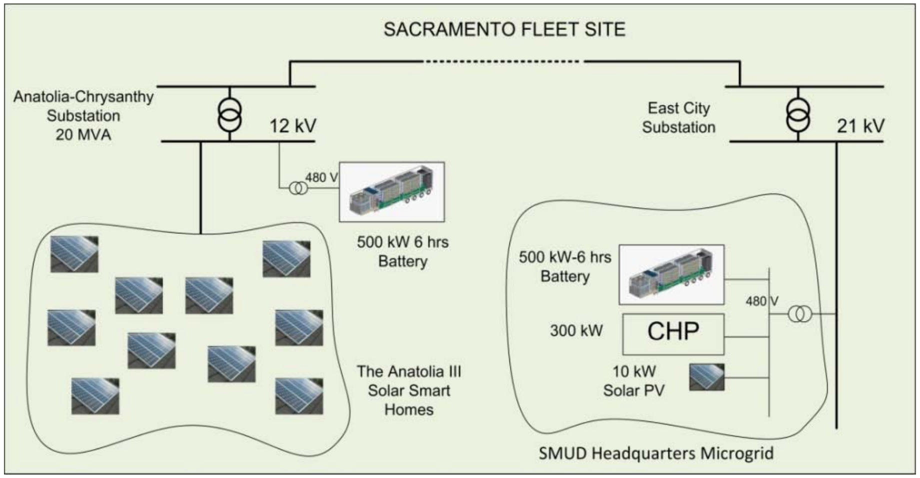




- **Anatolia SolarSmart^{SM} Homes Community**
  - High building efficiency measures
  - 2kW PV systems
- Installing 15 RES (10kW/8.8kWh) and 3 CES (30kW/30kWh)
- Will firm renewables, reduce peak load and improve reliability
- Partners include GridPoint, SunPower, Navigant, NREL, SAFT (lithium ion)
- Installing utility and customer portals to monitor PV, storage, customer load
- Sending price signals to affect changes in customer usage
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

Storage for Grid Support

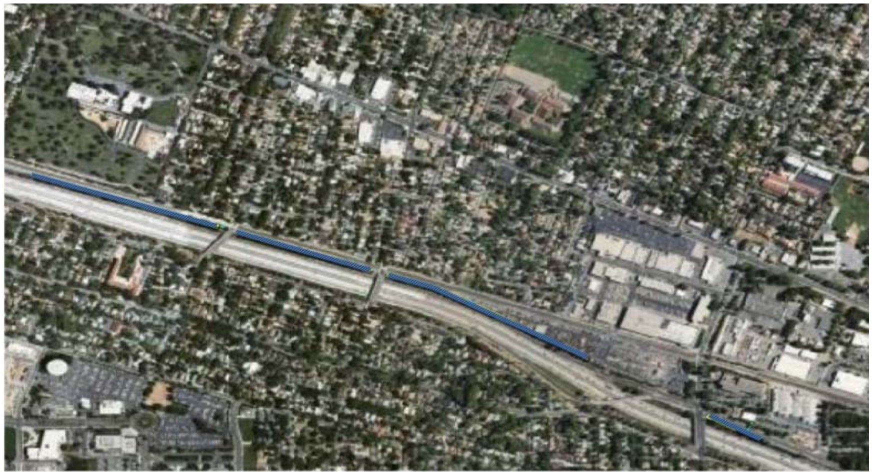
ARRA FOA 36 Storage Demonstrations (DOE Award DE-OE0000224)

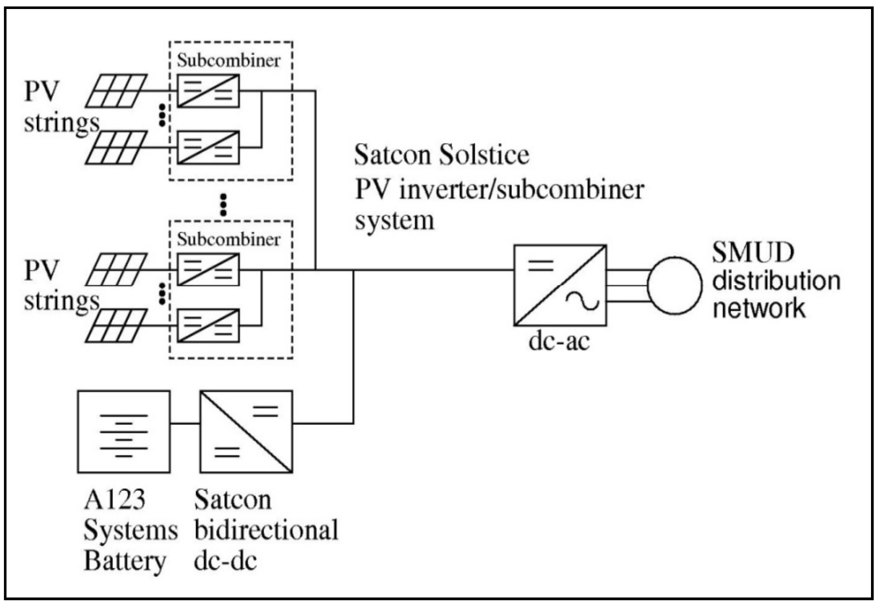


Benefit	Metric	Sacramento Fleet
Peak load reduction	Peak Load	5-10%
T&D loss reduction	T&D Losses	2%
Reduced cost of power interruption	CAIDI/SAIDI/SAIFI improvements	10%
Reduced damages as a result of lower GHG/carbon emissions	MWh served by renewable sources	TBD
Reduced cost to serve peak energy (energy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

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

Sacramento Solar Highways Augmentation





- New grant to add advanced technology
- $4.2M grant from CEC PIER
- SMUD is subcontractor to Satcon; A123 is other partner
- Advanced technologies:
  - Satcon 500kW Solstice advanced inverter technology
  - A123 500kW/500kWh lithium ion battery system
- Objectives
  - 5-12% improved solar harvest
  - Minimize impact of variability
  - Control ramp rates
  - Voltage regulation and voltage sag mitigation
  - Peak load shifting

SMUD's Pumped Hydro Storage Project

Key Features of Iowa Hill

- New development added to existing Upper American River Project (UARP), near Placerville, CA
- 400-MW Pumped-storage facility
- New 6,400 ac-ft reservoir atop Iowa Hill
- Existing Slab Creek Reservoir as lower reservoir
- Underground water conveyance and powerhouse
- 2.5-mile transmission tie-in connects to existing UARP transmission line

Benefits

- Helps meet load growth by increasing dependable capacity 400 MW
- Promotes intermittent, non-dispatchable renewable resources by helping to manage their energy output
- Supports load following, improves system reliability, provides voltage control and spinning reserves
- Variable-speed reversible turbines essentially deliver 800 MW of regulation value

Other Storage Activities

- Storage Valuation Model Development – EPRI Storage Program
- CAES for Wind Integration Assessment and Pilot – EPRI/SMUD
- NaNiCl Energy Storage coupled with PV Demo – EPRI/FIAMM/Satcon
- Storage, PV, Demand Response in SmartGrid Environment – pending
- Multi-MW/MWh Storage and PV Demo – pending
- Advanced Battery Pilot - pending

Sustainable Energy

A sustainable power supply is defined as one that reduces SMUD's ***long-term greenhouse gas emissions from generation of electricity to 10% of its 1990 carbon dioxide emission levels by 2050*** (i.e. - <350,000 metric tonnes/year), while ***assuring reliability of the system***; ***minimizing environmental impacts*** on land, habitat, water quality, and air quality; and ***maintaining a competitive position*** relative to other California electricity providers.