CEC Workshop: Wind Storage Enhanced Technologies on the Grid

Energy Storage Projects at SMUD

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SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.℠

Challenges for SMUD in Reaching High Wind Penetrations

- ☒ Small system size and low load factor
- ☒ Temperature driven peak loads—little wind on the hottest days
- ☒ Confined balancing area footprint
- ☒ No wind generation in our balancing area—all outside
- ☒ New 500 MW base load gas plant—less flexibility during minimum load hours
- ☒ New FERC UARP reservoir elevation limits—less operational flexibility

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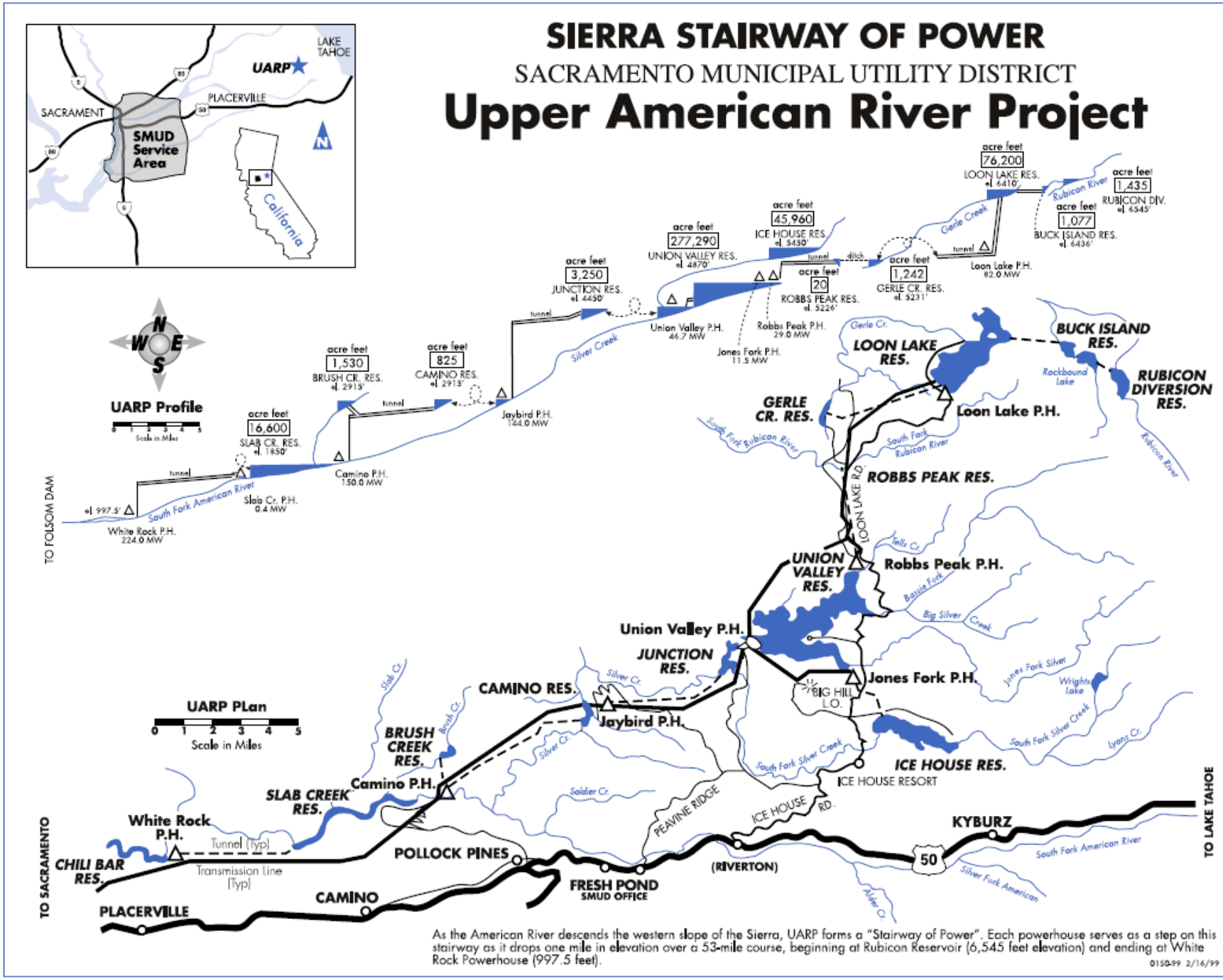
- ☑ PIRP participant—beneficial to SMUD

Some Thoughts on Wind Bulk Energy Storage

- Many recent wind integration studies have shown that:
  - Existing utility generation portfolios can provide for unit commitment, load following, and regulation services for modest wind penetrations at low costs
  - Utility access to large, fluid (especially in-the-day) energy markets can be very helpful in minimizing integration costs
- As wind penetrations increase, utilities will need more flexible scheduling & operations strategies, better wind forecasts, additional fast-ramping generators, and perhaps more flexible transmission policies (e.g., conditional firm, real-time ratings)
- With large wind penetrations, bulk storage may be needed but will likely be viable only if all economic value streams are considered and if capital costs drop appreciably relative to market energy costs
- Bulk storage may "compete" with the development of and access to robust energy markets (economic re-dispatch, ancillary services, PIRP)
- Currently, only 2.5% of utility energy sales in CA are from wind; the IAP study's 2020 scenario has approx. 15% of sales from wind yet new bulk energy storage was not shown to be needed

Current List of Projects

1) Iowa Hill Pumped Storage
2) Static Energy Storage for RT Light Rail
3) Vanadium Redox Battery System for Sprint Nextel
4) Off Peak Over Cooling (Thermal Storage)



As the American River descends the western slope of the Sierra, UARP forms a "Stairway of Power". Each powerhouse serves as a step on this stairway as it drops one mile in elevation over a 53-mile course, beginning at Rubicon Reservoir (6,545 feet elevation) and ending at White Rock Powerhouse (997.5 feet).

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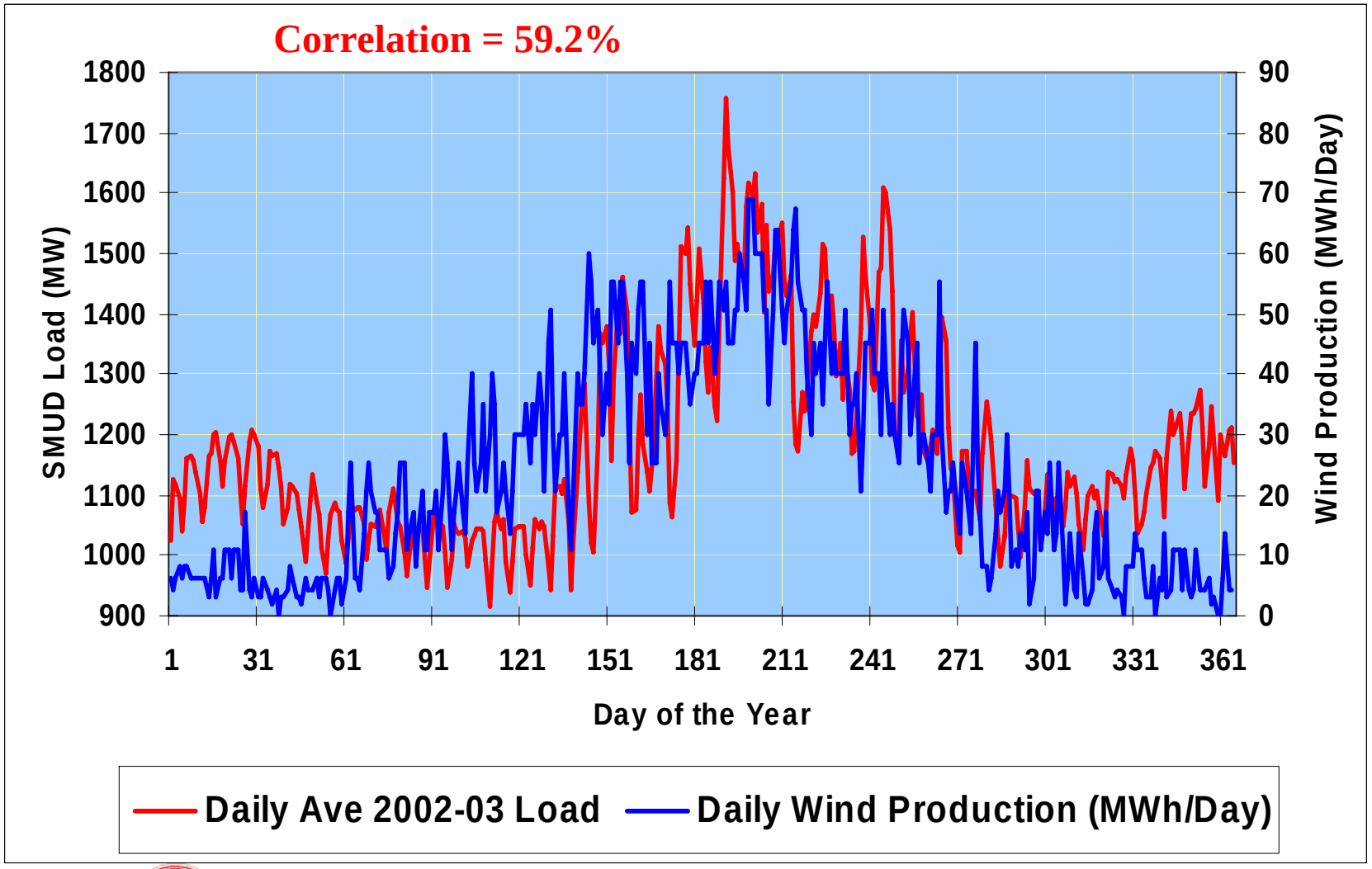
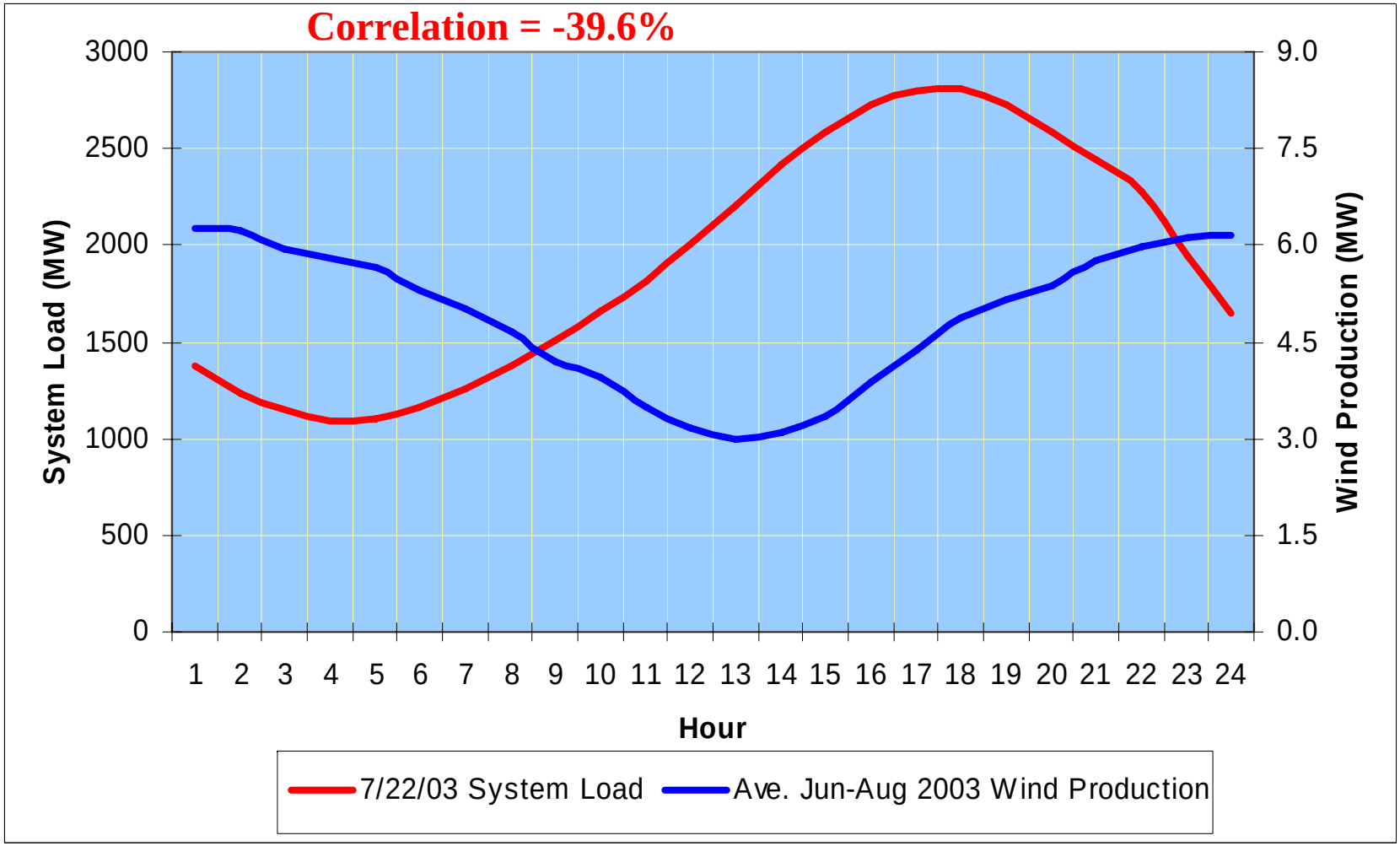
(1) Comparing **DAILY** System Load with Solano Wind Plant Production

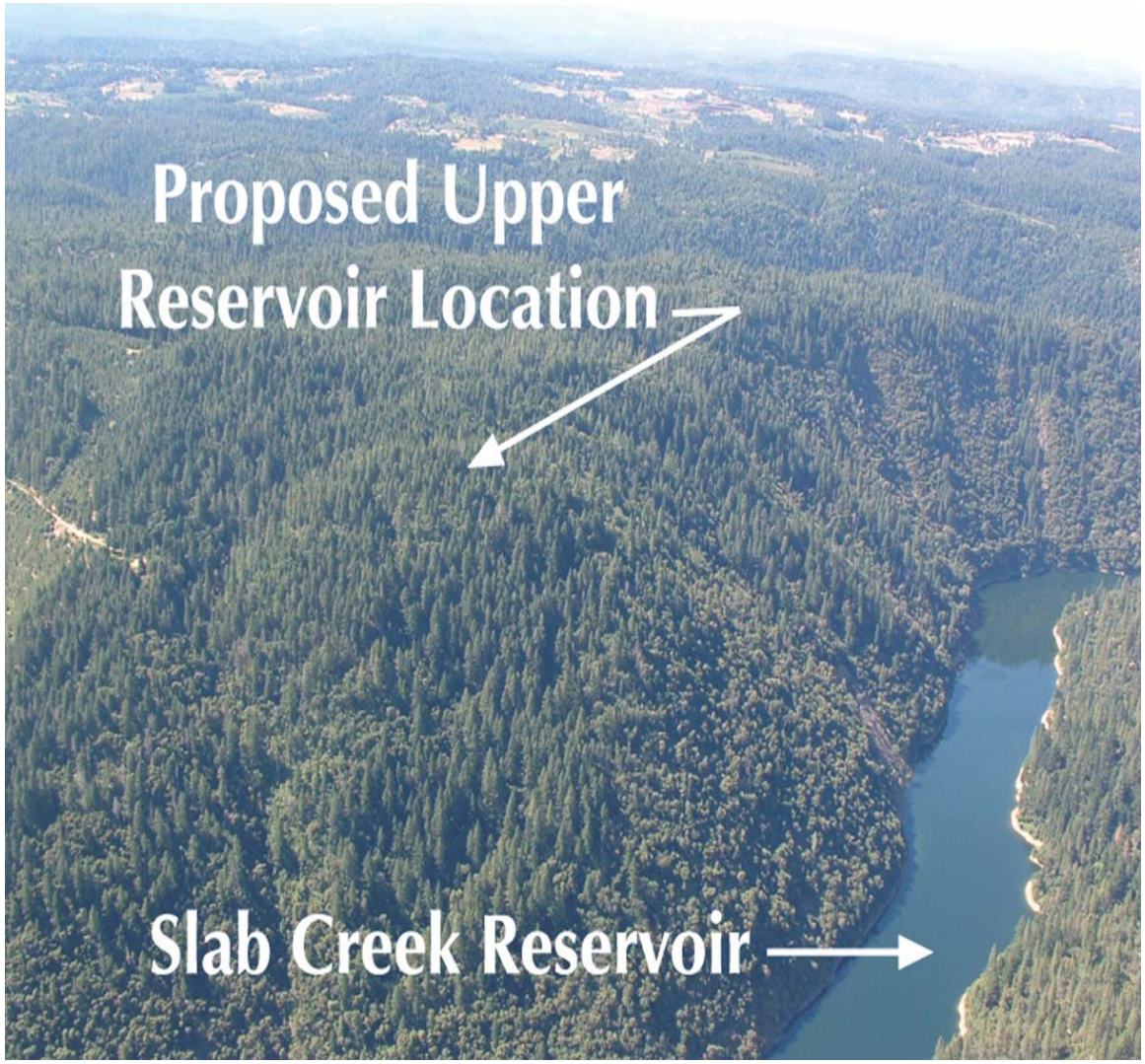


Comparing **HOURLY** System Load on a Hot Summer Day with Solano Wind Plant Production



Proposed 400 MW Iowa Hill Pumped Storage Facility

- 1200 ft. Lift
- 109 Acre Upper Reservoir
- 50 miles NW of SMUD's Service Territory
- 5 Year Project, Once Approved

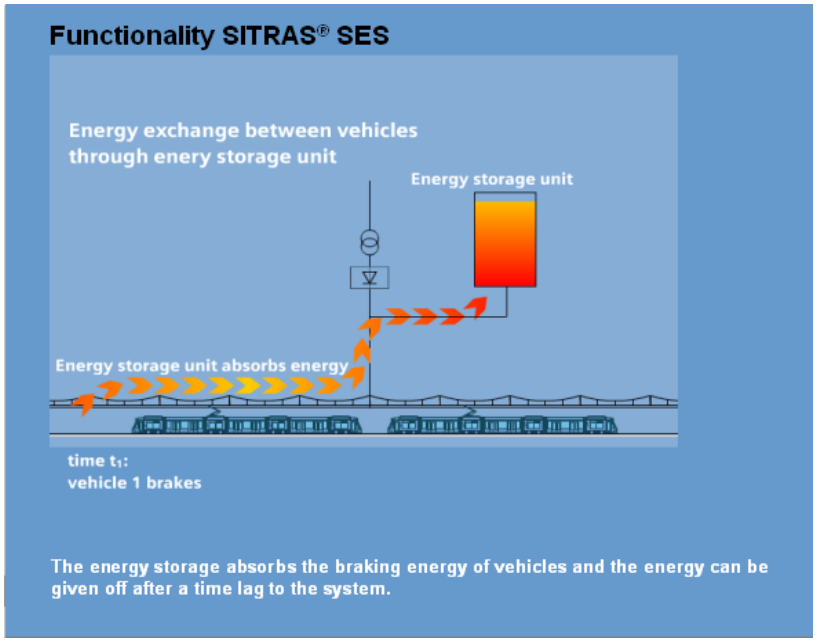


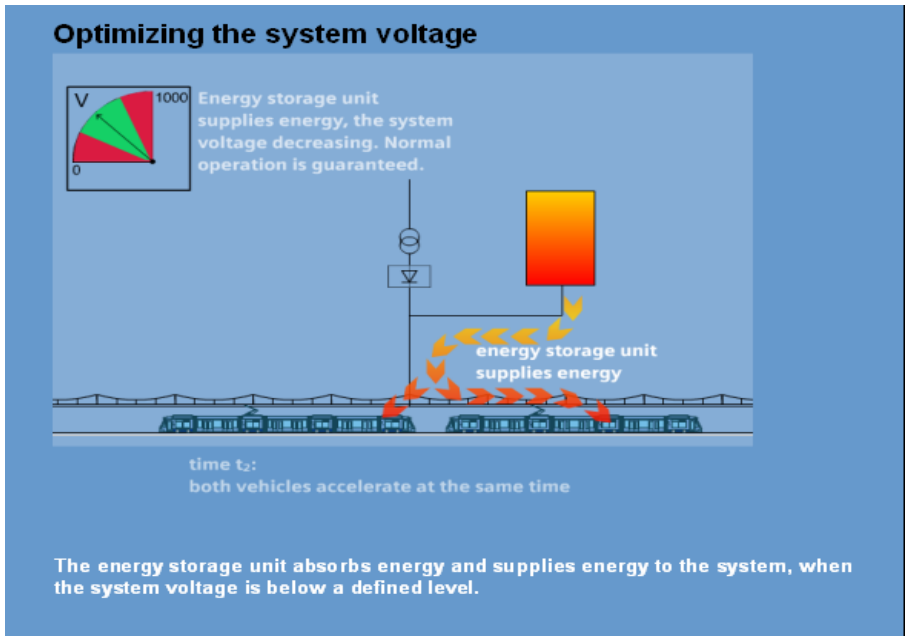
(2) Static Energy Storage Project:
Light Rail Energy Recovery

Static Energy Storage System

- **Technology demonstrated:** Capacitor Energy Storage for Energy Efficiency and DC Traction System Voltage Support
- **Customer:** Sacramento Regional Transit District
- **How does project work:**
  - Project will utilize parallel ultra-capacitor banks to form a 1 MW Static Energy Storage (SES) unit
  - SES will store energy from braking vehicles and use the energy later for train acceleration
  - The storage unit can be charged from regenerative braking for maximum efficiency or from the DC traction grid for maximum voltage stabilization.
- **Project Impacts and End User Benefits:**
  - Reduces power peaks and energy use
  - Stabilizes DC traction voltage when trains accelerate from station
  - Eliminates need for new conventional DC substation
  - SES cost is 50% less than conventional DC substation
  - Reduces operating and capital costs
- **Project Timeline:**
  Start: Summer 2007
  Commissioning: Summer 2008
  Field Trial: 2008 – 2009

Static Energy Storage Will Supplement RT Substation





(3) Vanadium Redox Battery System

- Demonstration of a 20kW x 9hr (180 kWh) system at a Sacramento Sprint Nextel facility
- VRB Power Systems from Vancouver, BC
- Objectives:
  - Enable peak load shifting; reduce utility costs
  - Replace existing lead acid battery UPS system
- Installation planned in January 2008

Vanadium Redox Battery for Peak Load Shifting & UPS

- **Technology demonstrated:** Vanadium Redox Battery Technology for Load Management of Telecom Customer's Load
- **Customer:** Sprint Nextel
- **How does project work:**
  Project applies 20 kW for 9 hours of VRB energy storage as a distributive energy storage system to provide peak load shifting, improved power quality and reactive energy support.
- **Project Impact:**
  - Demonstrates economic value of energy storage
  - Shift load from peak to off-peak
  - Replace lead acid batteries
- **End User Benefits**
  - Lower electric bill
  - Improve power quality
- **Project Timeline:**
  Start: Summer 2007
  Commission: Early 2008
  Field Trial: 2008-2009

Internal Site View of Rectifiers and Existing Batteries

VRB Power Systems' Moab Project Installed at the End of an 85 Mile Distribution Feeder

Inside the 2MWh PacifiCorp installation in Moab

(4) Off Peak Over Cooling Project

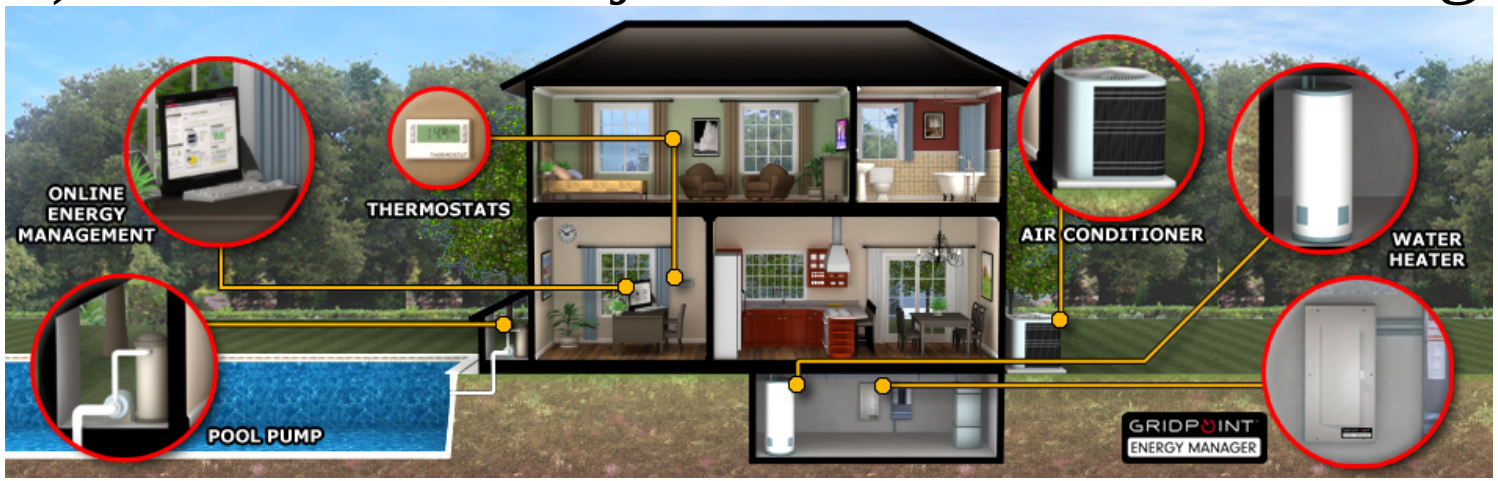
- Objective: reduce summer residential super peak load (5-8pm) by precooling using two methods:
  1) Nighttime ventilation to take advantage of large diurnal temperature profile
  2) AC system precools from 1-5pm
- Shut down AC at 5pm and let the indoor temperature drift upward until 8pm or until temperature reaches 80F

Off Peak Over Cooling

- Task 5 examined conceptual utility control of fleet of pre-cooled homes to provide system load reduction needed when actual **Solano Wind Project** production is less than forecast
- Results showed that a fleet of 10,000 homes could make up for the typical wind forecast errors of a 100 MW Solano wind plant
- Significant super peak load reductions occurred
- Still examining impact on total kWh use
- PIER final report being drafted now by subcontractor Davis Energy Group

Other Potential Storage Projects

1) GridPoint Project—includes PV Storage



2) Vehicle-to-Home Experiment