CEC's Energy R&D Program and the Potential for Storage Technologies APEC Energy Storage Workshop

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California Energy Commission

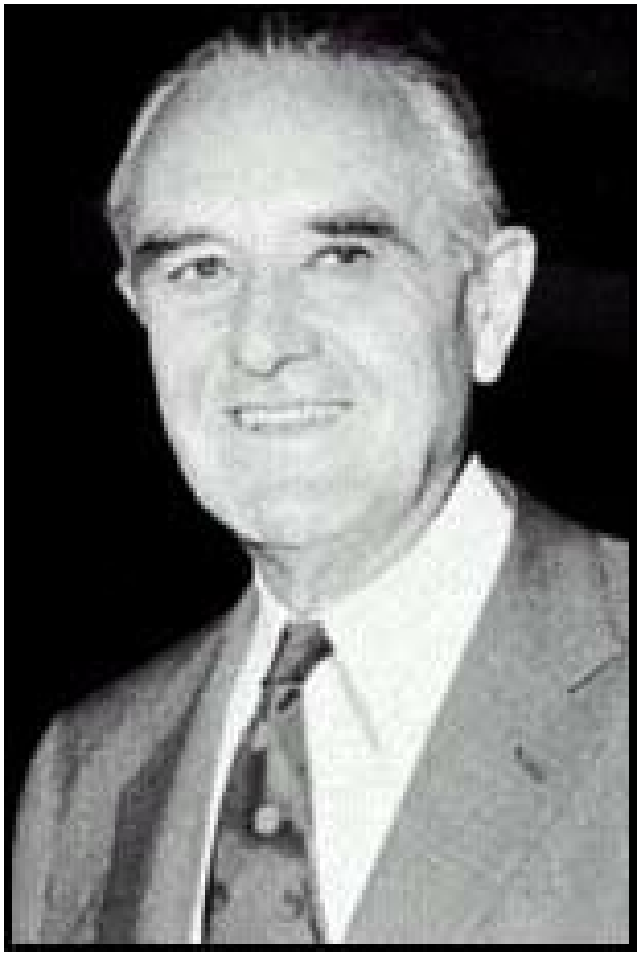
"Everyone is not entitled to an opinion. If they lack knowledge, they do not deserve to have an opinion."

Sir Winston Churchill

“Everybody wants to get into da act!”

Jimmy Durante

When asked how the negotiations were going, he responded...

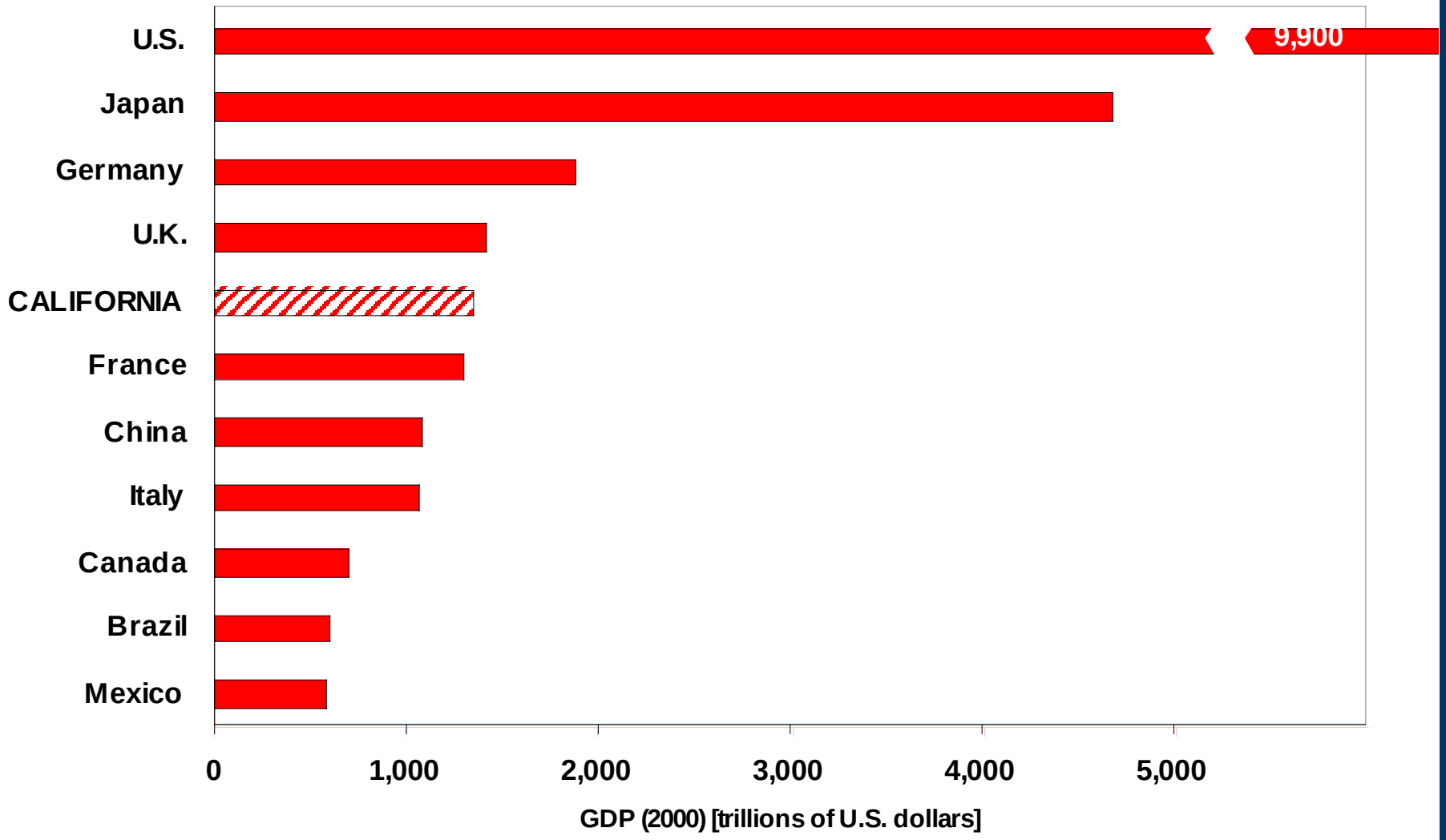


"About as distastefully as anticipated"

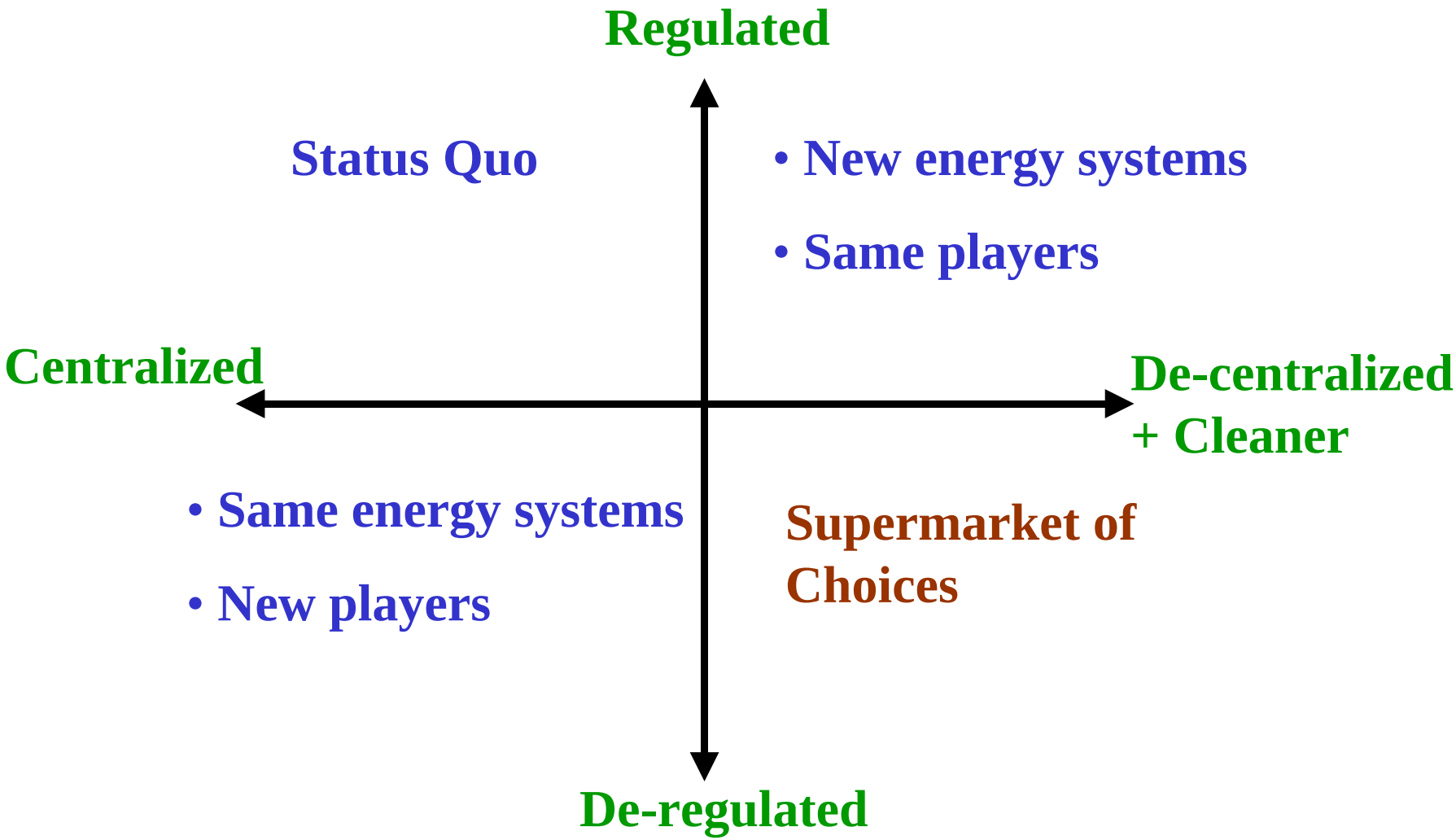
W. Averell Harriman

Stakeholder Consultation

GDP (2000)


U.S.
Japan
Germany
U.K.
CALIFORNIA
France
China
Italy
Canada
Brazil
Mexico
9,900
0
1,000
2,000
3,000
4,000
5,000
GDP (2000) [trillions of U.S. dollars]

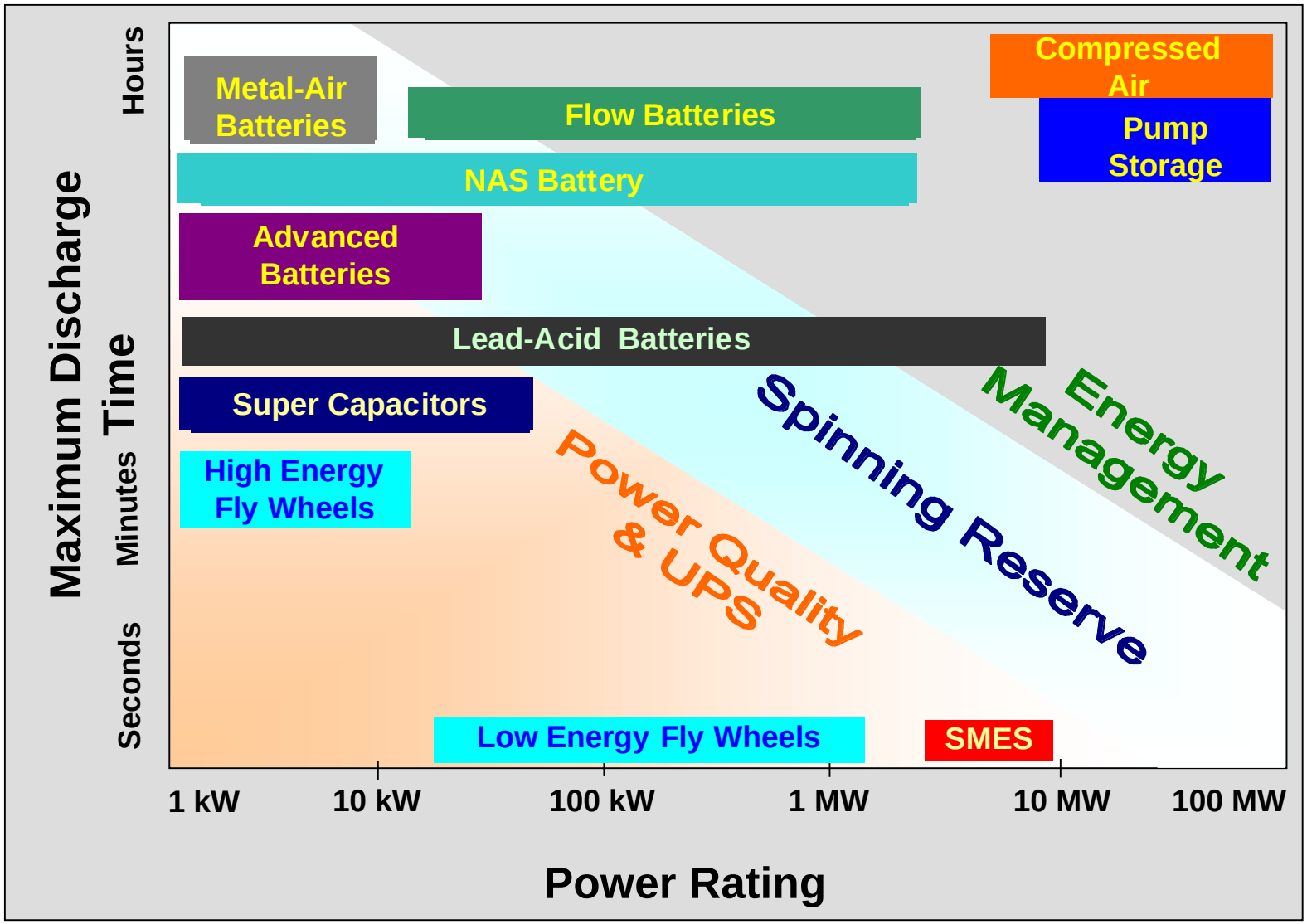
Our R&D Program Should Impact the Future Energy Marketplace



Reasons for PIER Interest in Storage Technologies

- Need to be responsive to the end-user and system needs
- Need to have tools for mitigating energy problems
- Newer emerging storage technologies that hold promise
- Demonstration for acceptance and integration into electricity system
- CA's needs present an opportunity for storage technologies ranging from less than a second for power quality oriented applications to several hours of energy as customer and system level backup
- Deregulation of energy made manifest the costs of instability and blackouts thus increasing the value of storage technologies

Multiple Storage Technologies for Varied Applications in California



Seeking a Solution with Value, Not Another Technology Demonstration

- Move beyond a technical demonstration.
- Demonstrate integration with the grid, user need and an economic viability.
- Facilitate the transition of a demonstrated technology to the next phase. Should not be commercially available, but show a large market potential. Provide immediate benefits to electric rate payers.

CEC/DOE Storage Technology R&D Was Meant to Prove "Value Principle"

- Under new law (SB 1038), CEC can engage in market transformation activities
- Can projects be economically viable – no need for just another demo
- Established criteria for targeted, programmatic solicitation
- Developed solicitation for storage applications in partnership with DOE and industry
- Awarded three demonstrations for integrated storage technology application

Collaboration with US DOE Was Essential for Program implementation

- Sponsored studies to assess the value of selected applications. This work built on the earlier work sponsored by the DOE for PJM area.
- Analysis focused on use of storage for selected applications with discernable economic benefits.
- Calculated the price goals the proposed projects have to meet for specified needs in California
- Used CEC program dollars, Doe support dollars and expertise

SPECIFIC PROBLEMS SEEKING SOLUTIONS

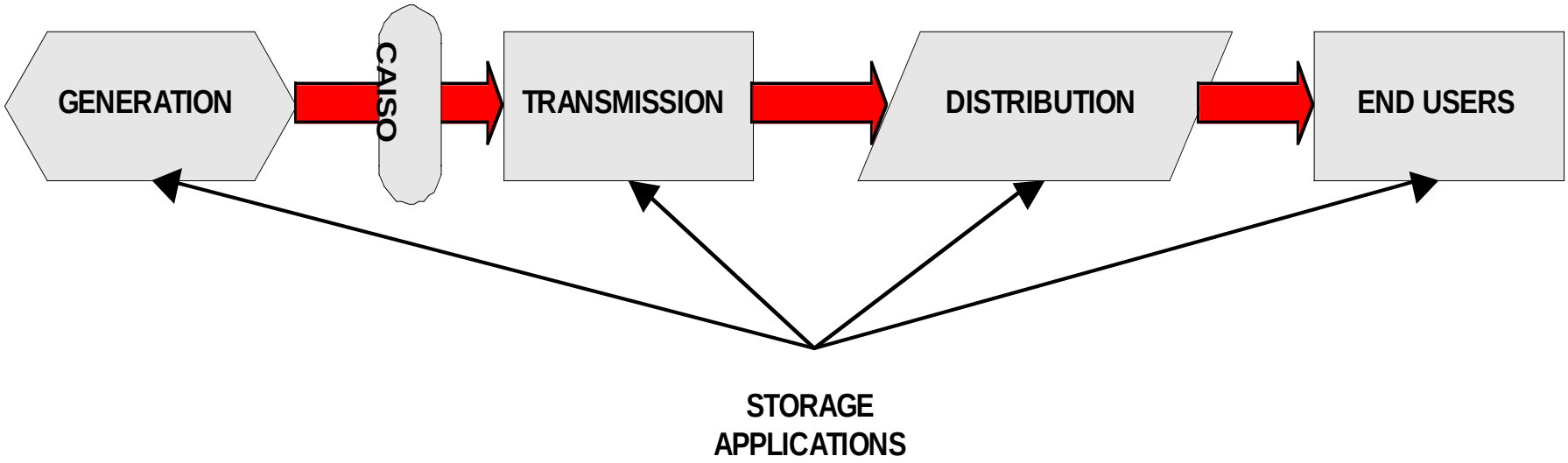
Renewable Resources

- 1700 MW of underutilized wind power
- Mandate for 20% Renewable use by 2010

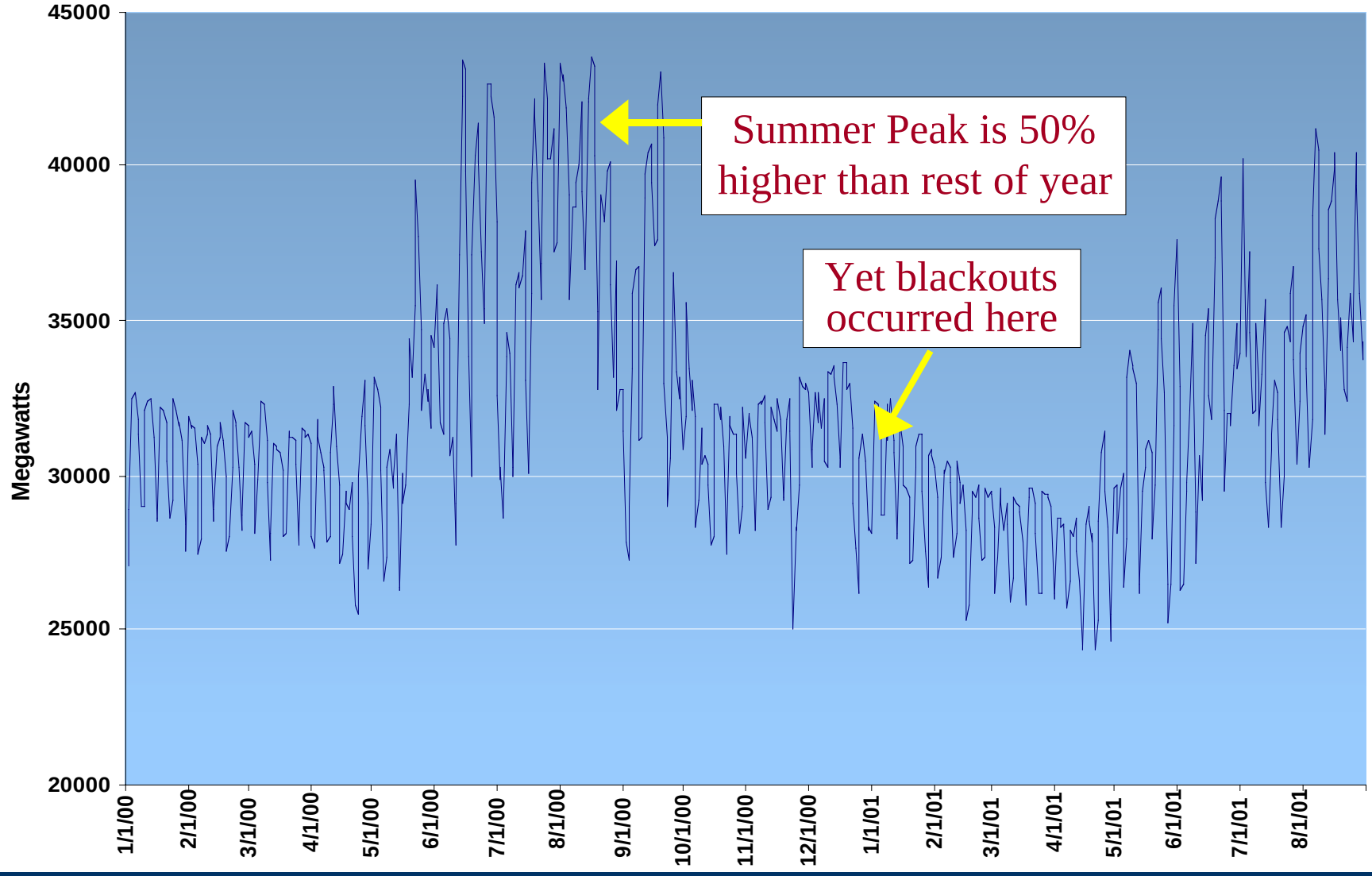
Transmission & Distribution Congestion

- Bottleneck at Path 15 joining CA north & south
- San Francisco transmission bottleneck

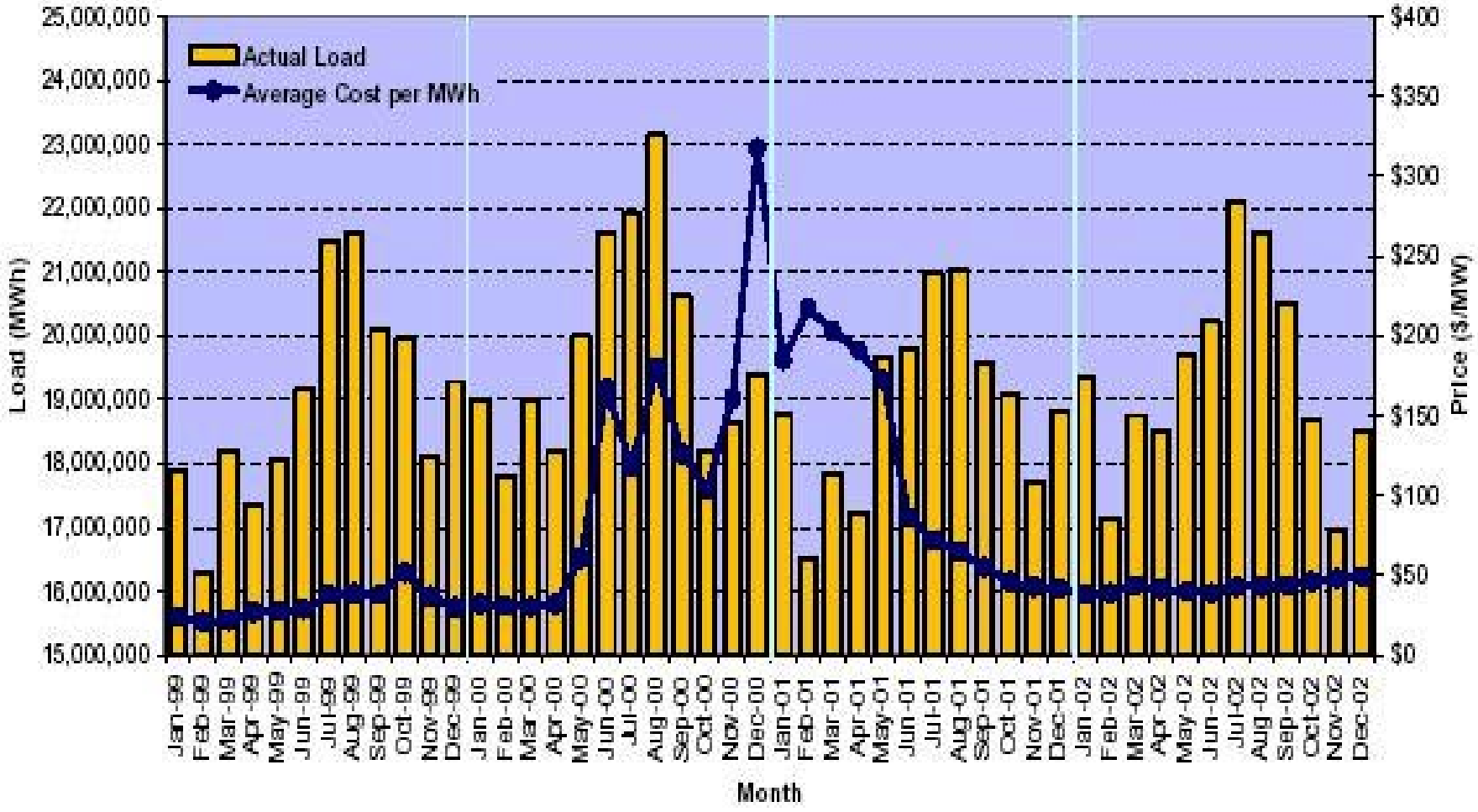
Storage Applications Throughout the California Electrical System



ISO Daily Peak Loads
January 2000 - August 31, 2001

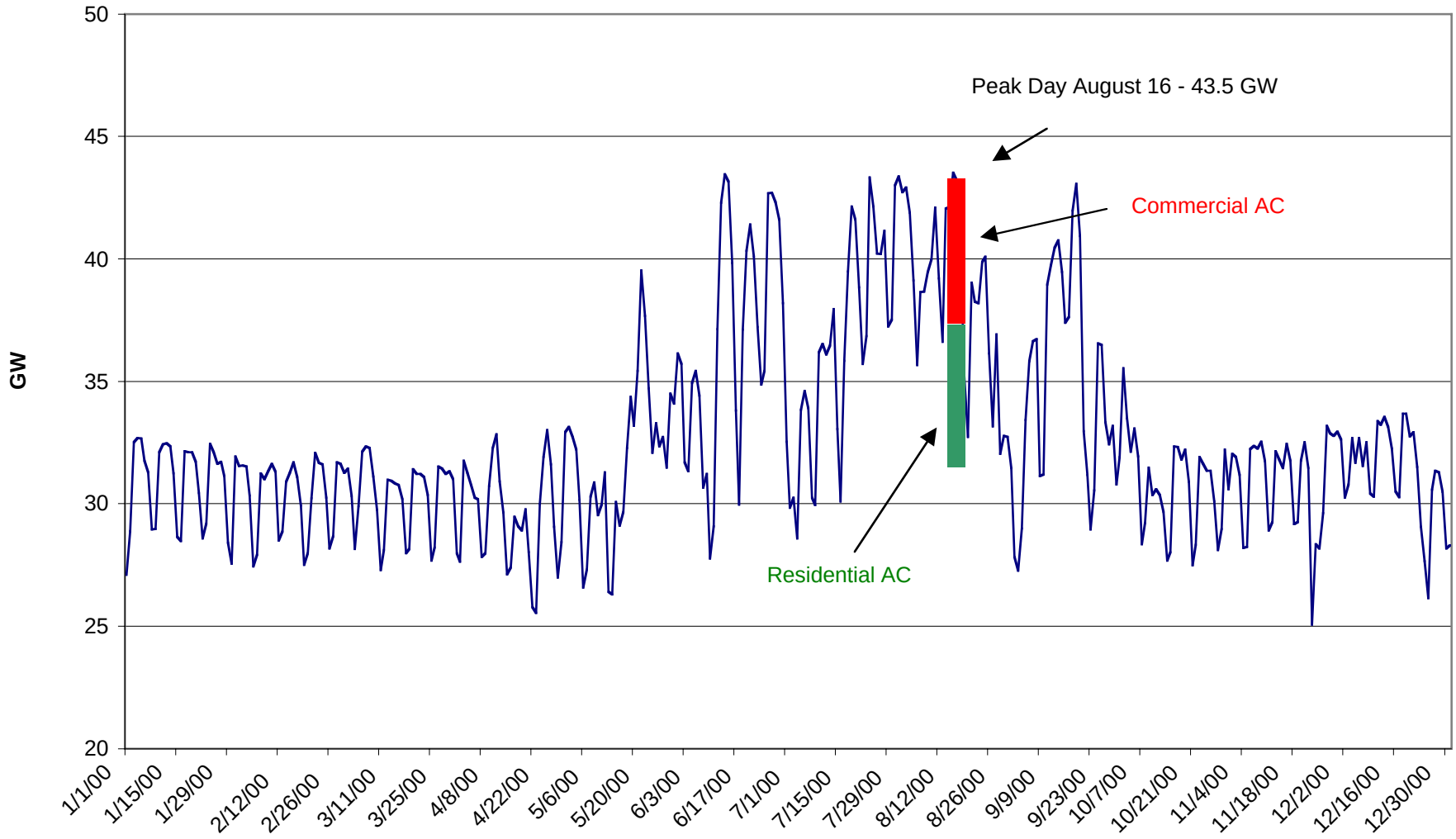


Monthly Load and Average Energy Costs to Serve Load



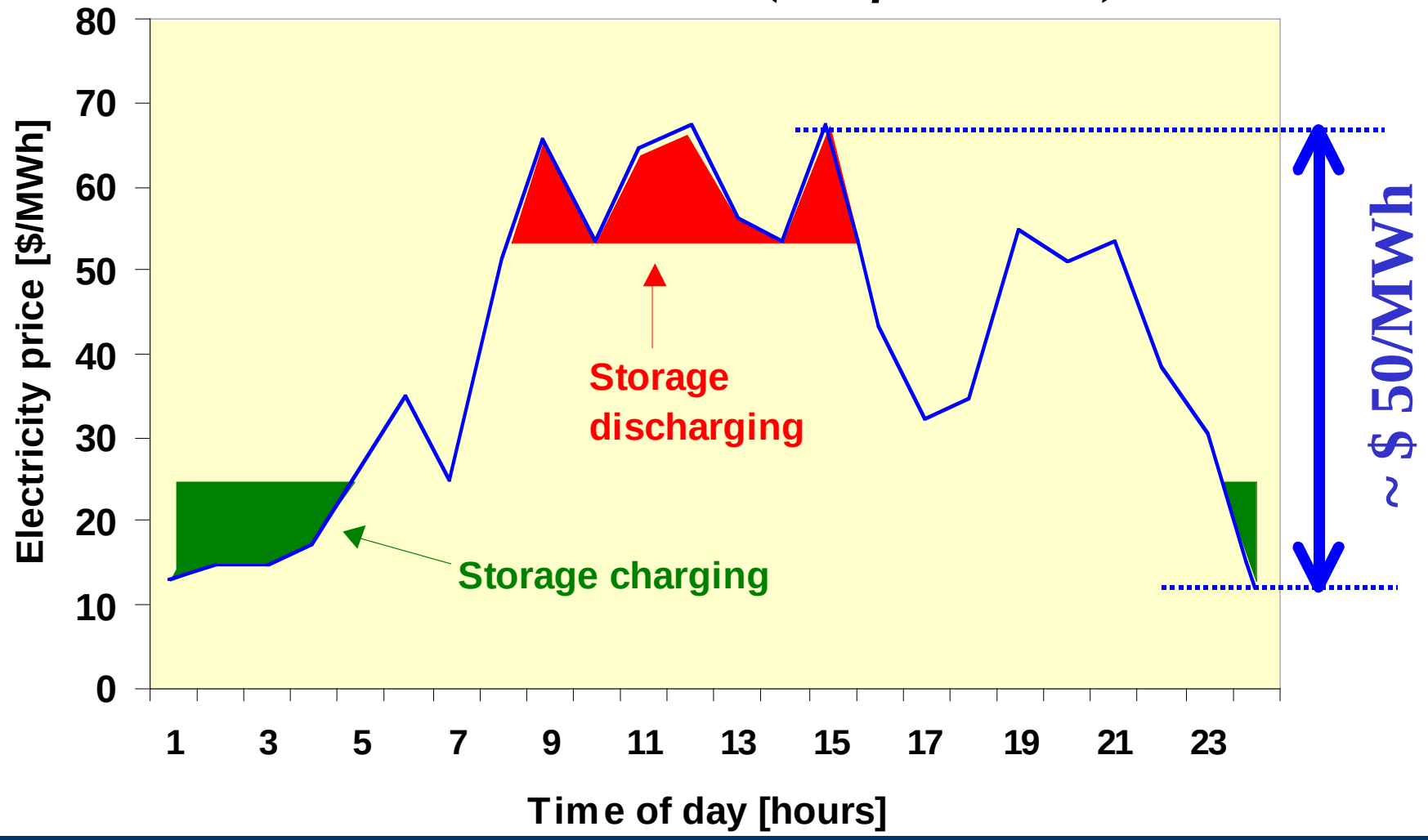
CAL ISO Daily Peak Loads

January 1, 2000 - December 31, 2000



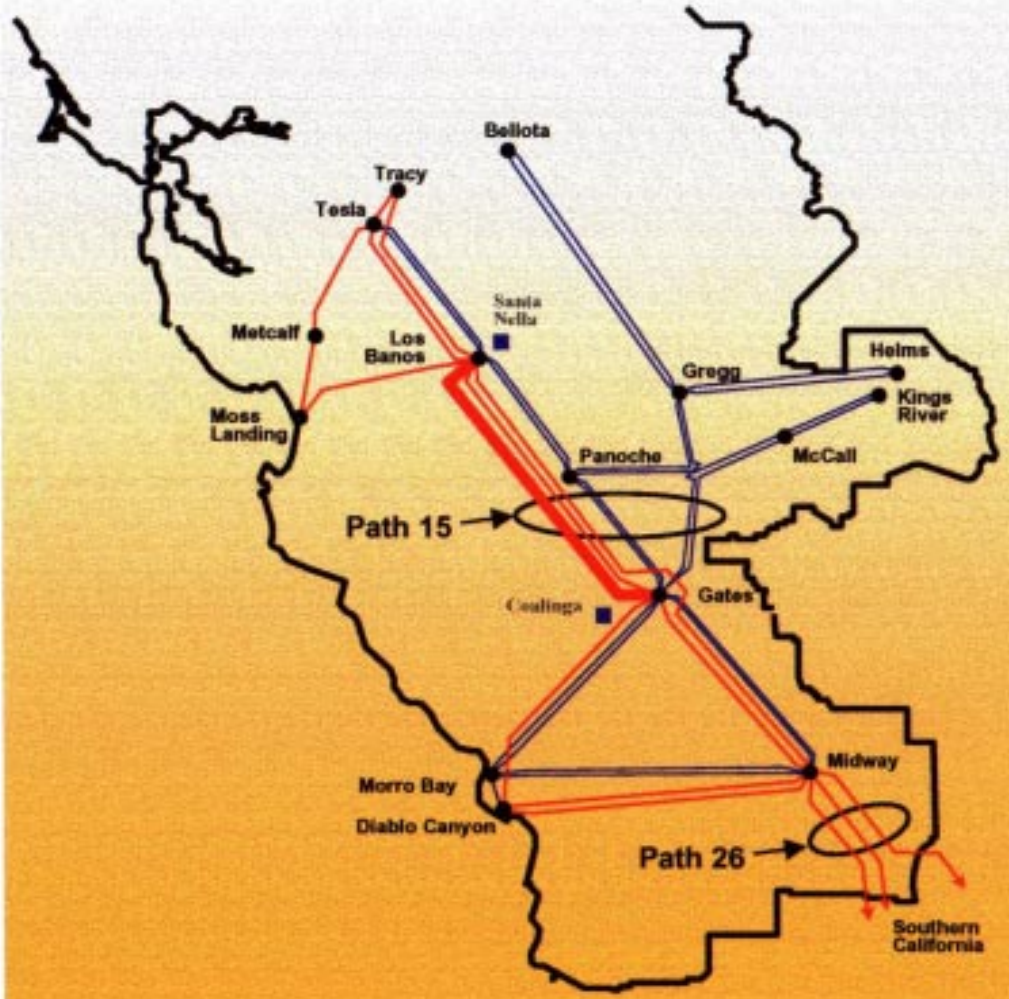
CA Real Time Electricity Price Daily Variations

For March 11, 2002 (California ISO)



CALIFORNIA ISO
Path 15 Upgrade Project

California Independent System Operator



- Install a single circuit 500 kV transmission line between Los Banos and Gates Substations.
- Perform 500kV work at Los Banos and Gates Substations.
- Install 250 MVAR of 230 kV shunt capacitors at both the Gates and Los Banos Substations.
- Install 230 kV substation upgrades at Gates and Midway.
- Modify the remedial actions in Path 15 and north and south of path 15.

SPECIFIC PROBLEMS SEEKING SOLUTIONS

Industrial & Commercial Customers

- Required to shed loads at short notice
- Want to reduce peak demand charges
- Want pollution free back-up power
- Put premium on reliability & power quality

Criteria for Selecting Projects Under California/US DOE Program

- **Electricity storage applications that deliver tangible, well defined economic value to host site or customer**
- **Applications that can be replicated several times within California and nationally**
- **Those that have been demonstrated at a pilot scale and are beyond the "proof-of-concept"**
- **Build on the work done by US DOE and others to avoid repetition**

Applications

- Bulk Electricity Price Arbitrage
- Utility T & D Deferral
- Customer Time-of-Use Cost Savings
- Customer Demand Charge Cost Savings
- Customer Premium Power
- Onsite Generation Time-Shift (Off-Peak to On-Peak)
- Renewables Capacity Firming
- Renewables Contractual Time-of-production Payments

Application Valuation &Market Potential Estimates

Storage Market Potential Estimates				
Application	**Composite $/kW**	**Hours of Storage**	**Upper Bound 10 Year Market Potential (GW)**	**10 Year Storage Market Potential (Millions $)**
Energy Arbitrage	435	4	10	5,000
T&D Deferral	399	2	2.5	1,250
Energy Arbitrage + T&D Deferral	834	4	2.5	1,250
Transmission Constraints	625	6	0.8	400
Time of Use Rates	592	6	3.3	1,700
Demand Charge	40	6	3.3?	1,700?
Microgrid	391	6	1.0	500
Renewables Capacity Firming	100	6	0.1?	50?
Renewables Time Shifting	396	6	0.2	100

Possible Limitations of the Proposed Approach

- Not aware of other good applications.
- Valuation method may be not be precise or based on questionable assumptions.
- Market Potential could be optimistic.
- Screening process is uncommon and complicated.
- Optimistic technology cost & industry capabilities.

Team Building to Bid on Turn-key Projects

We encouraged a complete team of vendor, user and system integrator to submit turn-key proposals

- Contacted CA utilities to encourage them to host and/or sponsor a demonstration project
- Contacted customer and field application related associations to encourage them to host and/or sponsor a demonstration project
- Attempted to assist emerging electric energy storage technology providers in matching their capabilities with prospective demonstration project sites

EES RFP Results

- **RFP released on July 31, 2003**
  - **RFP goal was to award 4-5 contracts (not to exceed $5 million)**
- **Received 14 notices of intent-to-bid**
- **Received 7 proposals**
  - **1 failed administrative screen**
  - **2 failed technical screen**
- **4 proposals passed all screens and were scored**
  - **3 proposals recommended for future contract award**

RFP Scoring Committee Recommends Three Proposals for PIER Funding

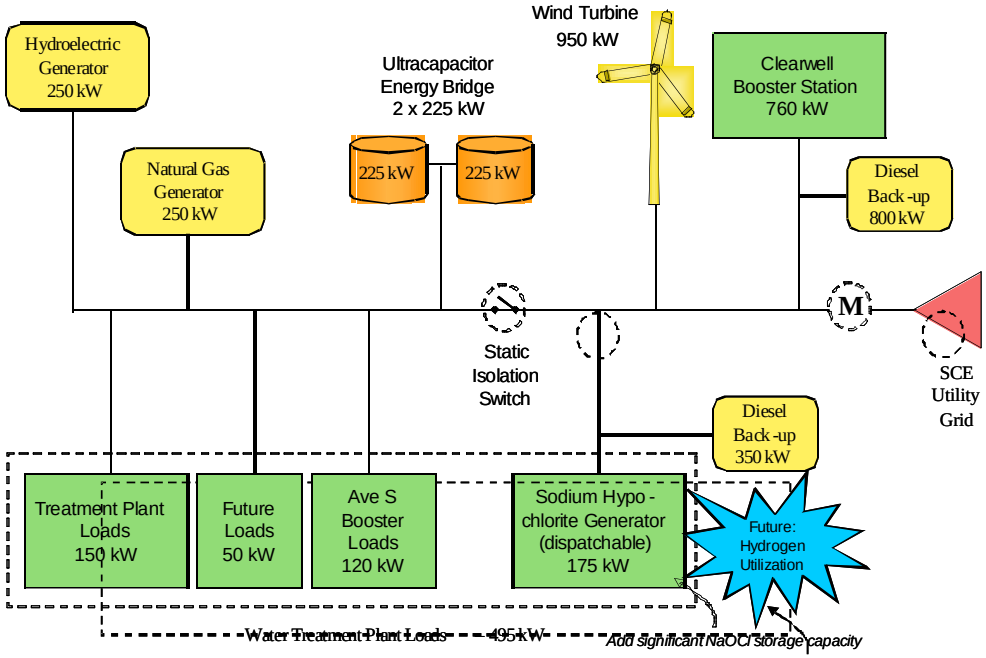
- Integration of wind, hydro and DG in MicroGrid using ultracapacitors
- Demonstration of ZBB energy storage system for substation upgrade deferral
- Flywheel Energy Storage System (FESS) Demonstration for kWh savings in Electrified Transit Networks

Energy Storage Enabled Renewable MicroGrid Power Network

- **Pier Funding: $987K (22%)----------(Total Project Costs: $4,376K)**
- **Technology demonstrated: Integration of wind, hydro & DG in MicroGrid using ultracapacitors**
- **Utility: SCE**
- **End Customer: Palmdale Water District**
- **Target Market:**
  - **Enhance DG and Renewable use by utilities and end customers**
  - **T&D congestion relief for utilities, ISO and ESPs**
  - **End customer reliability**
  - **Demand response for end customers and utilities**
  - **Back-up power and power quality for end customers**
- **Market Penetration Factors**
  - **Product has market pull--addressing issues critical to California and US**
  - **Wide range of potential applications of technology**
  - **Provides flexibility and demonstrates performance of enabling technology**
  - **PIER project provides actual costs and benefit comparisons for new customers**
  - **Integrated solution has more value to utilities and end customers**

Energy Storage Enabled Renewable MicroGrid Power Network

Palmdale Water Treatment Plant
Energy Storage Enabled MicroGrid® Power Network



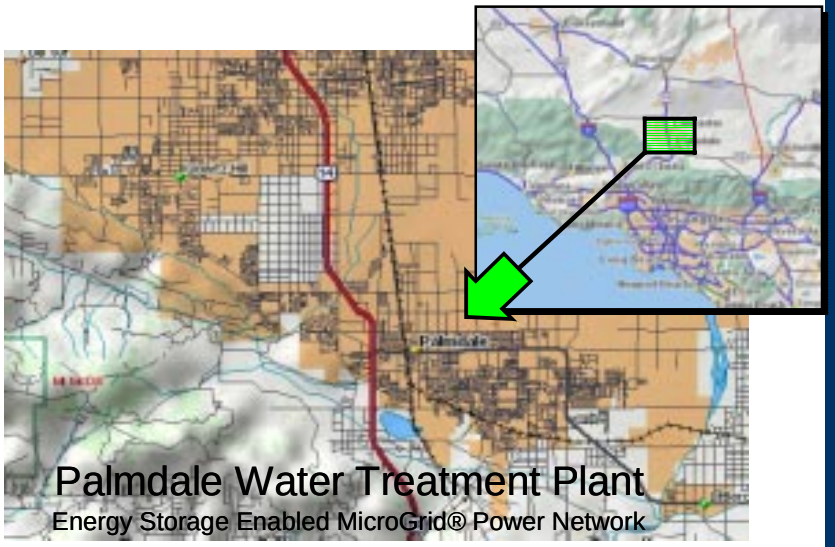
- Project will integrate a 950kW wind turbine, 250 kW hydro and 250kW natural gas generator into a MicroGrid using 450kW ultra-capacitor.

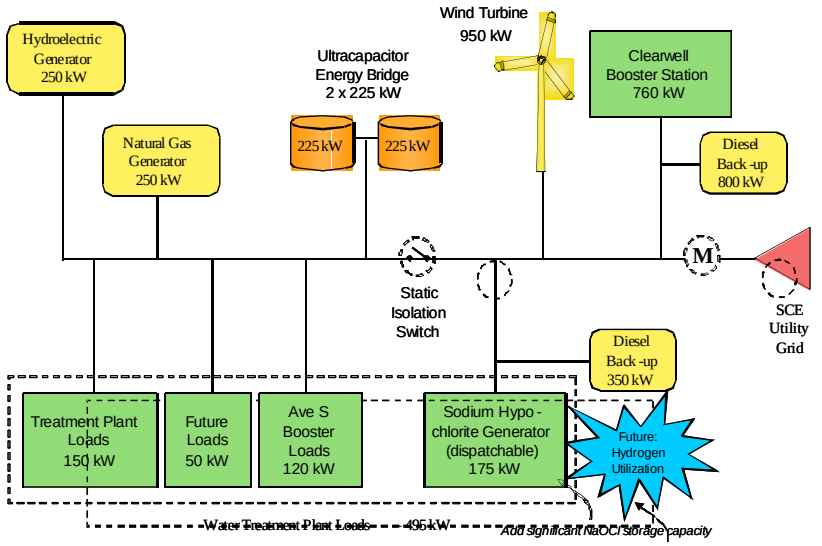
How does project work:

- Ultracapacitor storage technology is used as an energy bridge to enable the smooth transfer of renewables and DG technologies.
- Project Impact: Enable the growth of DG and MicroGrids
  Apply energy storage as enabling technology.
  Provide critical missing link for renewable & DG integration

Energy Storage Enabled Renewable MicroGrid Power Network

- **Project Timeline:**
  - **Start: April 2004**
  - **Commission: August 2005**
  - **Field Trial: 8/2005 – 12/2007**
- **System Benefits**
  - **T&D congestion relief**
  - **T&D support (ancillary services)**
  - **Improved system reliability**
  - **Increased DR use enabling technology**
  - **Enhance renewable integration**
  - **Improved network power quality**
- **End User Benefits**
  - **Reduced energy costs**
  - **Improved power quality**
  - **Back-up power protection**
  - **Improved system reliability**





Demonstration of ZBB Energy Storage System

- Pier Funding: $1,873K (76%)----------Total Project Costs: $2,475K
- Technology demonstrated: Zinc-Bromine battery storage for substation upgrade deferral
- Utility: PG&E
- End Customer: PG&E
- Target Market:
  - T&D Congestion relief for utilities, ISO, and ESPs
  - T&D Deferral for utilities, ISO, and ESPs
  - Demand response for end customers and utilities
  - Back-up power and power quality for end customers
- Market Penetration Factors
  - System mobile—rapid response to critical T&D utility need
    - Provides flexibility and demonstrates enabling technology
  - Market Pull--addressing issues critical to California and US

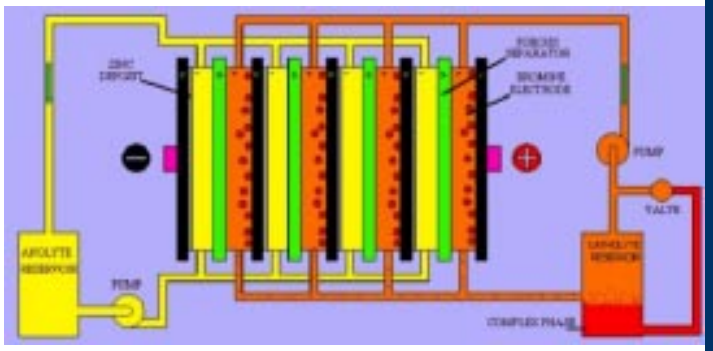
Demonstration of ZBB Energy Storage System

- **Project will demonstrate the value of using battery energy to improve T&D Congestion conditions and defer T&D upgrades**
- **How does project Work:**
  - **Transportable 2MW/2MWH battery energy storage will be installed at PG&E substation to demonstrate and assess value of T&D congestion relief & upgrade deferral.**
- **Project Impact:**
  - **T&D system reliability improvement**
  - **Demonstrate economic impact of applying energy storage to T&D problems**
  - **Validates the use of DUIT project as a utility acceptance testing site.**

Demonstration of ZBB Energy Storage System

- **Project Timeline:**
  - **Start: April 2004**
  - **Commission: October 2005**
  - **Field Trial: 10/2005 – 9/2007**
- **System Benefits**
  - **T&D upgrade deferral**
  - **T&D congestion relief**
  - **T&D support (ancillary services)**
  - **Improved system reliability**
  - **Improved network power quality**
- **End User Benefits**
  - **Continue to use T&D resources without making system upgrade**
  - **Improved system flexibility**
  - **Improved system reliability**

The Flowing Electrolyte Battery System

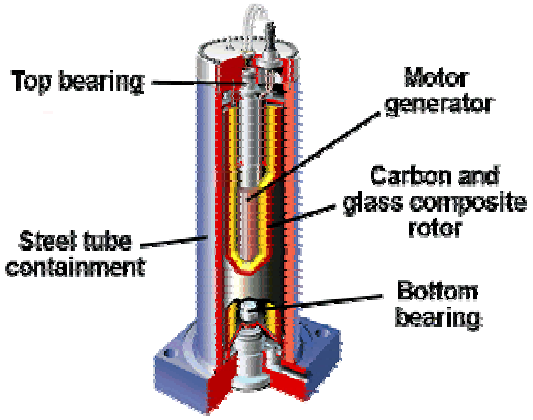


Flywheel Energy Storage System (FESS) Demonstration for Electrified Transit Networks

- **Pier Funding: $891K (58%)----------(Total Project Costs: $1545K)**
- **Technology demonstrated: Flywheel Energy Storage for kWh savings in electrified transit networks**
- **Utility: San Francisco PUC**
- **End Customer: San Francisco Municipal Railway**
- **Target Market:**
  - **Energy savings for public transit agencies (7 in California)**
    - **Large users of electricity—top 2 or 3 customer for each servicing utility**
  - **T&D congestion relief for utilities, ISO and ESPs**
    - **Peak load reduction for utility and end customer during critical times**
  - **Improved end customer reliability**
  - **Improves power quality for nearby customers on electric grid**
- **Market Penetration Factors**
  - **Substantial energy saving potential 15-20%**
  - **PIER project provides actual costs and benefit comparisons for new customers**
  - **Adoption by one field system will result in market pull from others if end performance meets or exceeds expectations.**

Flywheel Energy Storage System (FESS) Demonstration for Electrified Transit Networks

- **Project will demonstrate capturing regenerative energy and diverting this energy into flywheel energy storage so it can be usefully used instead of wasted as heat**
- **How does project Work:**
  - **When electric trains slow down at stations, the regenerative braking energy is transferred to the flywheel and then transferred back to accelerate the train when it departs the station (100s of times a day)**
- **Project Impact:**
  - **Capture and use energy that is currently wasted as heat**
  - **T&D peak load reductions of up to 15-20% of Muni system load (during peak demand times and other times)**
  - **Potentially used by 7 CA transportation systems at 460 stations.**



Flywheel Energy Storage System (FESS) Demonstration for Electrified Transit Networks

- **Project Timeline:**
  - **Start: April 2004**
  - **Commission: August 2005**
  - **Field Trial: 7/2005 – 11/2007**
- **System Benefits**
  - **T&D congestion relief**
  - **Improved system reliability**
  - **Improved network power quality**
- **End User Benefits**
  - **Reduced energy consumption**
  - **Stabilize system voltage**
  - **Extend capacity of substations**
  - **Improved system flexibility**

EES RFP—Lessons Learned

- **RFP was a clear effort to identify a "line in the sand" where R&D energy storage technologies are ready for a commercialization push in near term**
  - **CEC, DOE and Industry all had voice in defining the line**
  - **Proposals were rejected by CEC based on the definition**
  - **Industry representatives did not submit based on the line**
- **Overall results indicated effort was successful**
- **Independent verification "Value Proposition" has strong potential of accelerating the commercial acceptance of the technology**

Status Update

- Three approved energy storage proposals in the final stages of contract completion. Contract initiation expected by June 2004
- DOE has awarded contracts to the two independent verification contractors
  - EPRI-PEAC Corporation for performance analysis
  - Distributed Utility Associates (DUA) for Value Proposition verification
  - Both contractors will complete independent analysis of the field performance of all three selected energy storage technologies
- Commission staff continuing to work with industry and end users to identify other potential energy storage research and demonstrations opportunities

Final Thoughts

- After all the interest, response was underwhelming
  - Tacit acknowledgement that technology providers are not as far along as they advertise
- Positive benefit of catalyzing additional interaction between utilities, CAISO, CEC, technology providers, DOE
- Particular thanks and credit due to Joe Iannucci of Distributed Utilities Associates