Integrated Energy Policy Report Workshop

on

Emerging Technologies

for the Integration of Renewables

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California Energy Commission

Objective of Workshop

- Support the development of the 2008 and 2009 Integrated Energy Policy Report (IEPR)
- Discuss the emerging technologies that can impact the integration renewables in California
- Discuss the emerging technologies that can accelerate the penetration of renewables in California by 2020
- Obtain feedback on the state of emerging technologies and commercialization prospects of key technologies
- Discuss method to accelerate the development and commercial fielding of key emerging technologies that are expected to impact the integration of renewables in California
- Develop recommended inputs for the 2008 IEPR

Workshop Agenda

- **Opening Comments**
- **Energy Commission Infrastructure R&D to Support the Integration of Renewables** (Mike Gravely)
- **Energy Commission Renewables R & D** (Gerry Braun)
- **Emerging Renewables Initiatives Under Review by the CPUC** (Jaclyn Marks, CPUC)
- **Wind Forecasting Efforts to Improve Renewable Penetration** (John Zack, AWS Truwind)
- **High Temperature Solar-Coupled Thermal Storage** (Ray Dracker, Solar Millennium)
- **Lunch**

Workshop Agenda

- **Panel Discussion on Emerging Technologies to Increase the Penetration and Availability of Renewables**
  - ***Energy Storage: (Robert Schainker, EPRI)***
  - ***Emerging Technologies to increase capacity, enhance stability and mitigate congestion (Merwin Brown, CIEE)***
  - ***Intermittent renewables cost and value with and without storage (Dariush Shirmohammadi, Oak Creek Energy)***
  - ***Distributed Energy Resources to Increase System Renewables (Bill Steeley, EPRI)***
- **Panel Discussion on Renewable Energy Deployment at Community and Distribution levels**
  - ***The case for Community Scale Photovoltaics (Joe, Henri, SunEdison)***
  - ***European models of wind energy deployment: Wind at Community and Building/Industrial Scale (Case Van Dam, CWEC)***
- **Public Comments**
- **Closing Comments**

Infrastructure R&D to Support the Integration of Renewables

Michael Gravely
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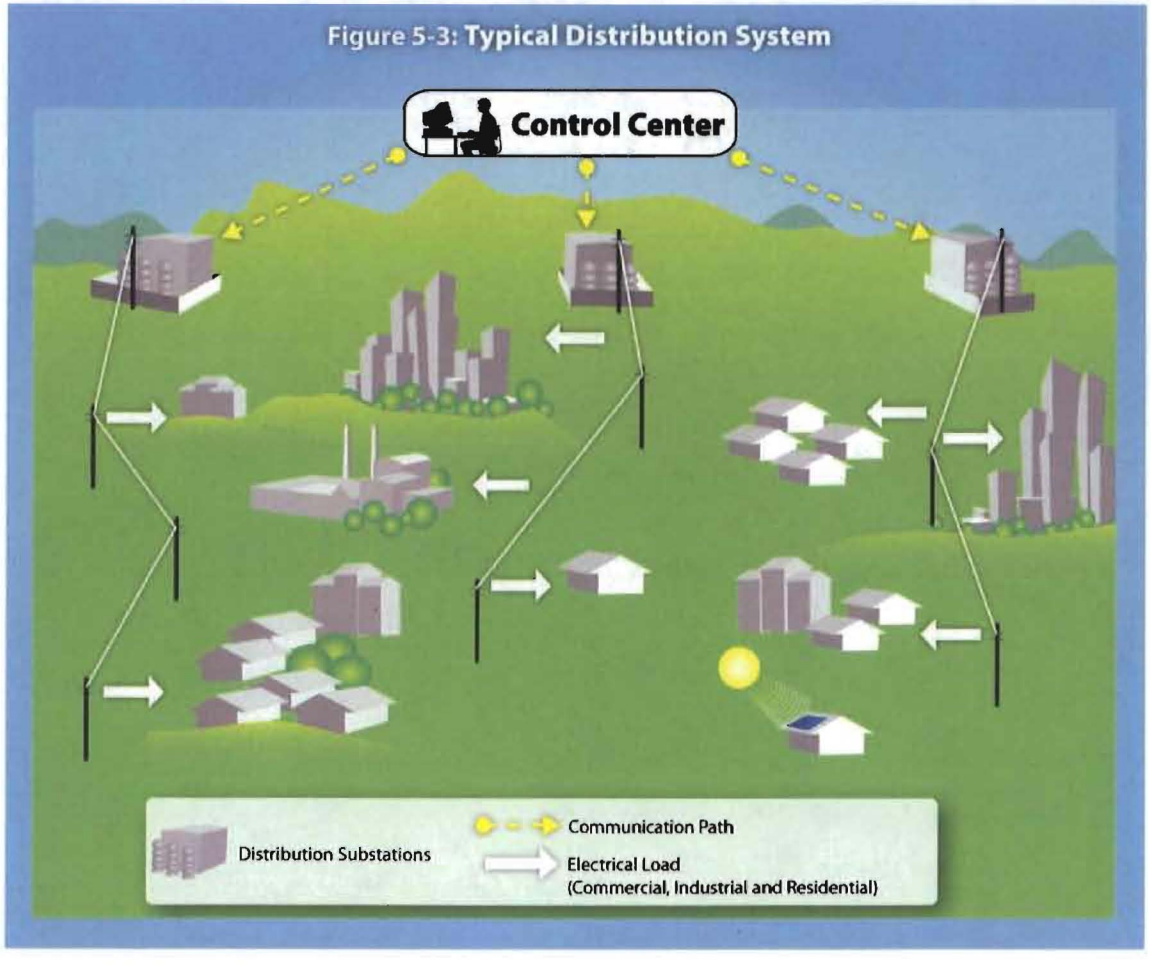
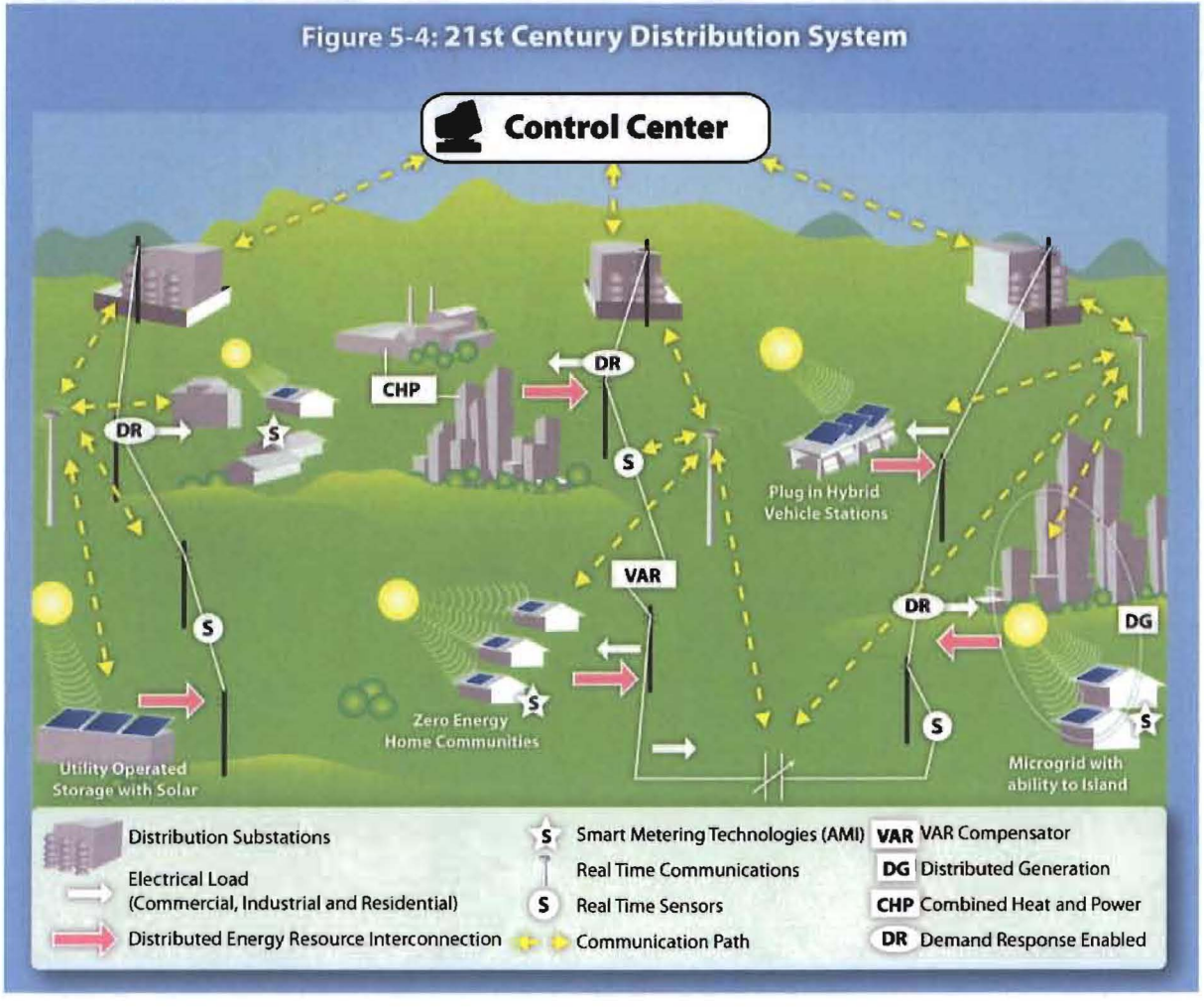
Strategic View – Utility Grid of Today



Source: 2007 IEPR

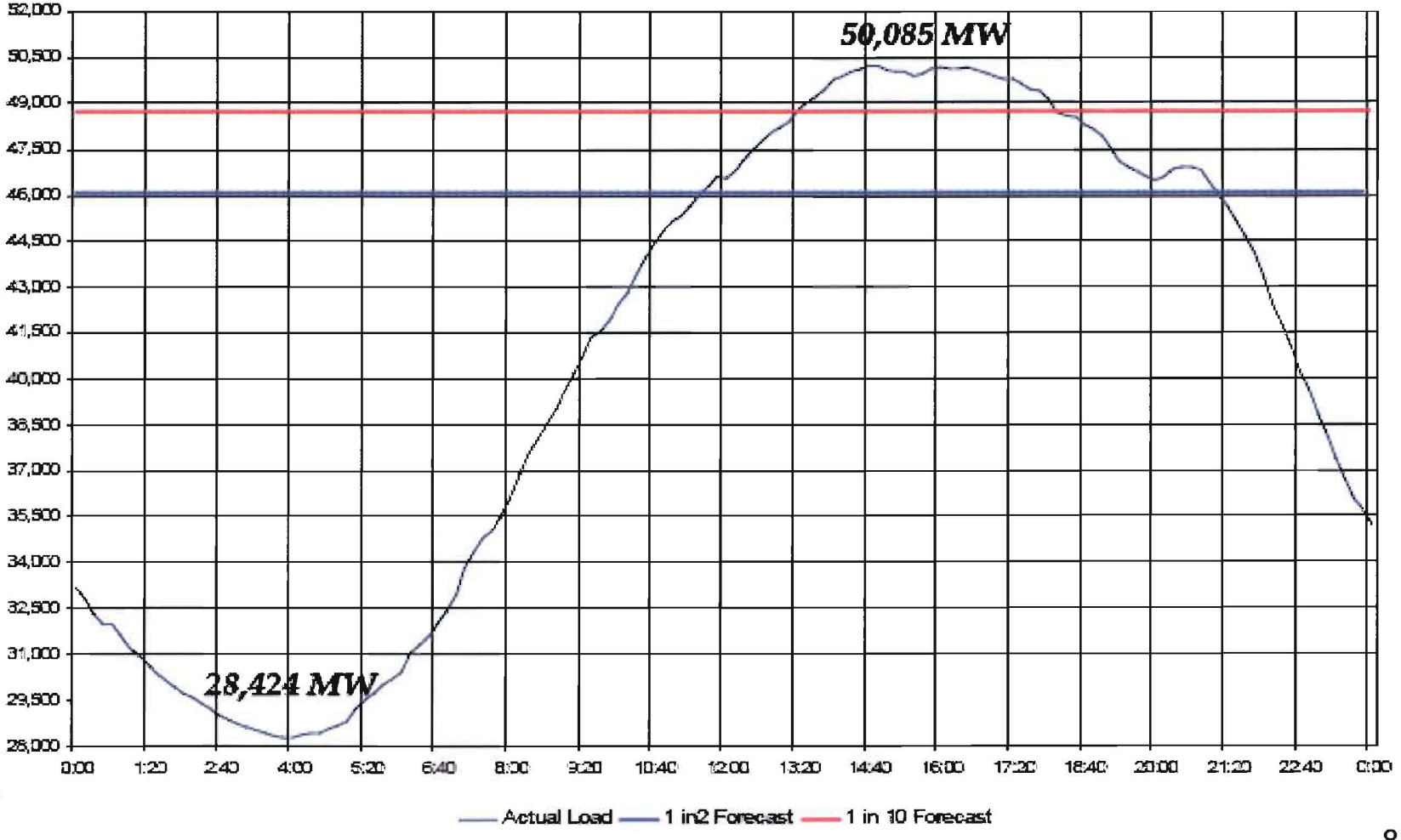
Strategic View – Utility Grid of the Future (Smart Grid)



Source: 2007 IEPR

California's Electricity Demand is Dynamic

CAISO Load Curve July 24, 2006



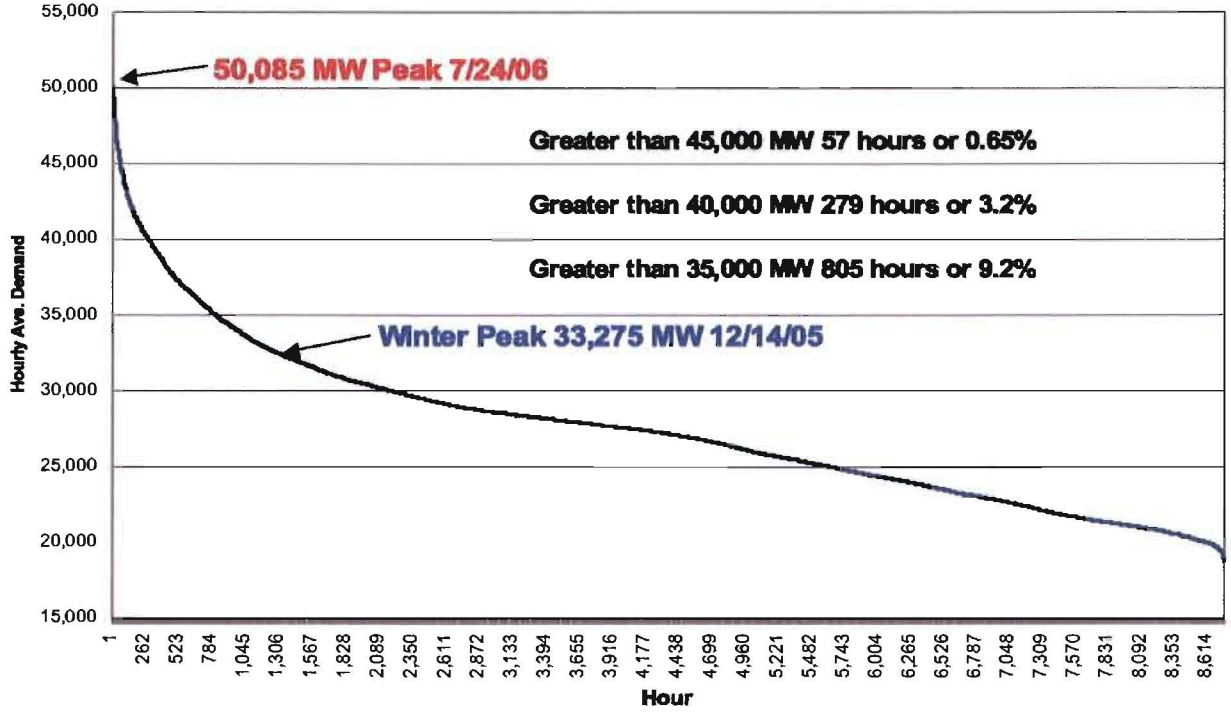
California's Highest Peak Loads Occur Less Than 60 Hours Per Year

California ISO
Your Link to Power

California Independent
System Operator Corporation

CAISO Load Duration Curve

Sept '05 to Sept '06



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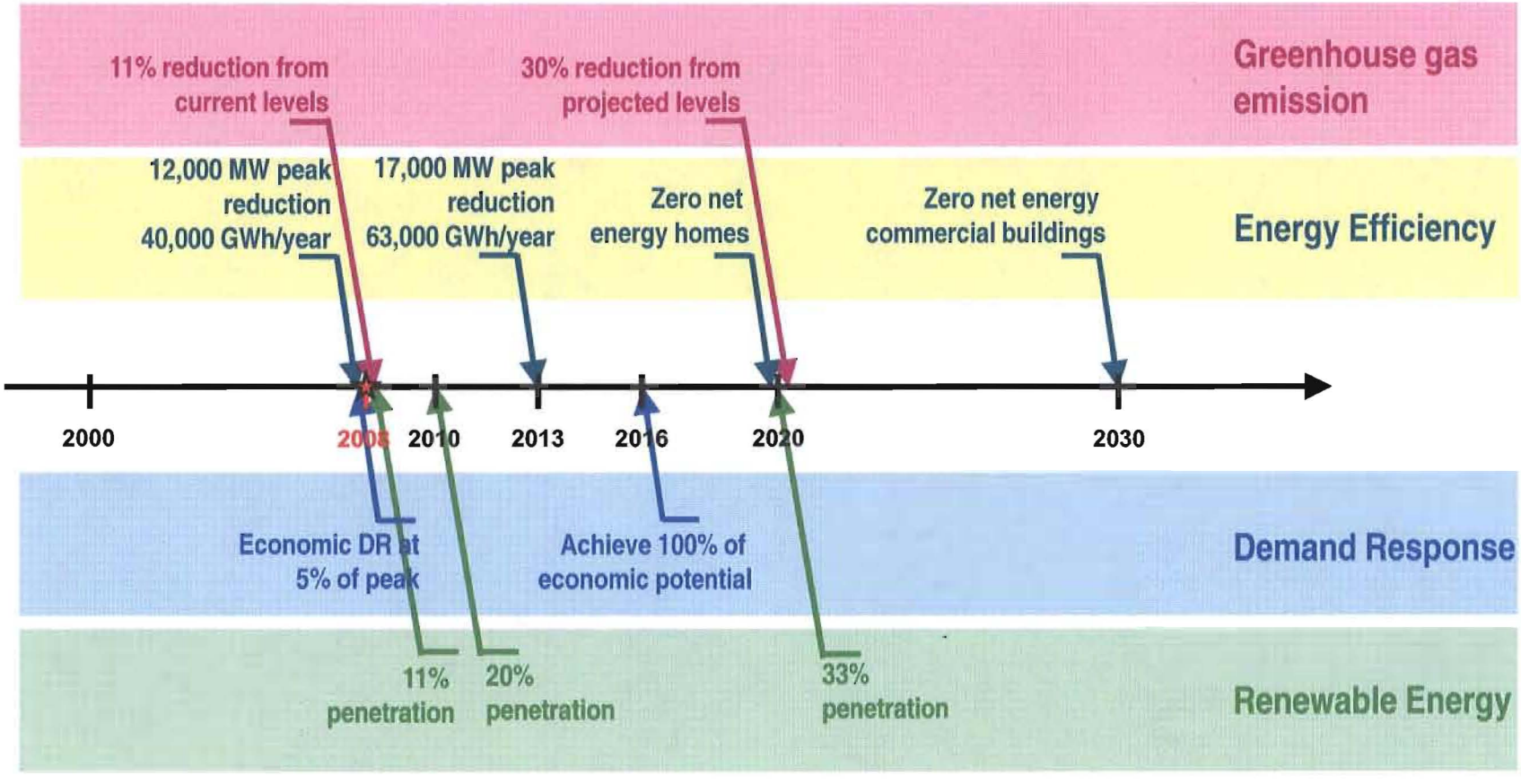
California Energy Policy Targets



Smart Grid Research at All Levels

Transmission

- Phasor Measurement
- Advanced displays
- Advanced comm & controls
- MRTU interface
- Energy Storage
- Renewables

Distribution

- Distribution Automation
- AMI
- Advanced C&C
- MRTU
- Energy Storage
- Renewables

Integration

- Renewables
- Standards
- Protocols
- Reference designs
- Micro Grids
- Automation

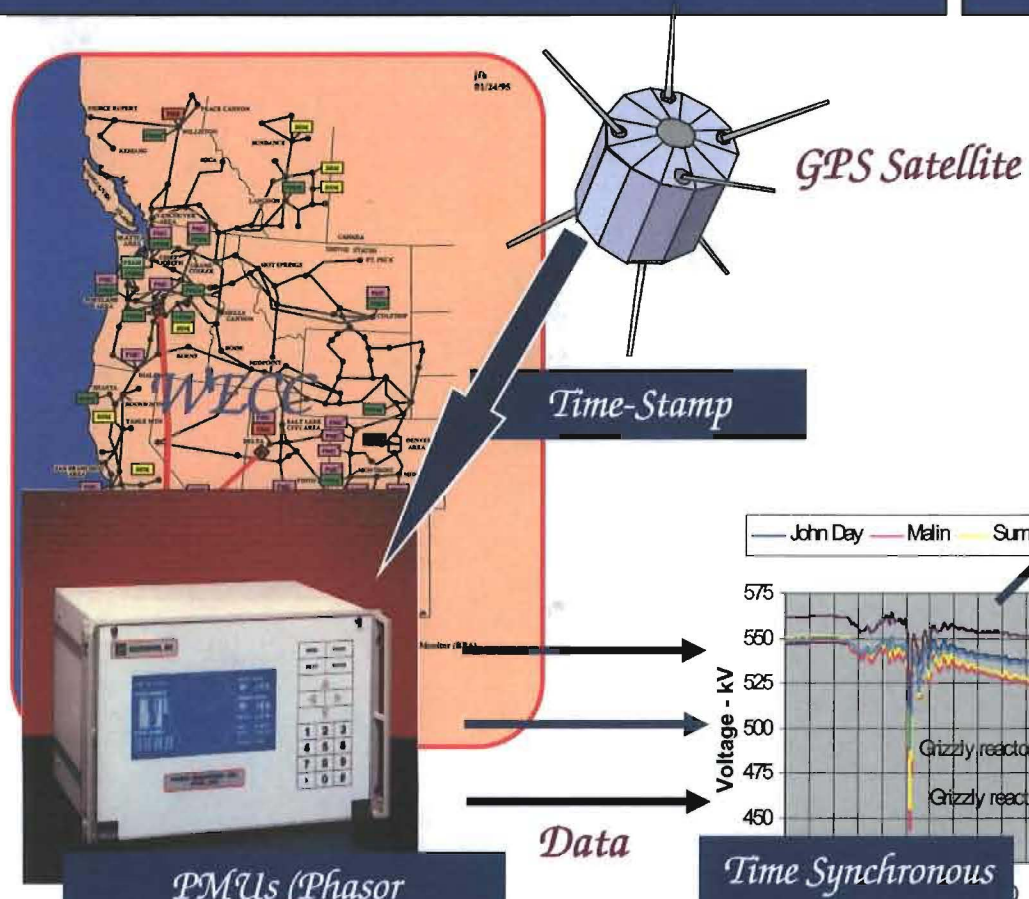
Consumer

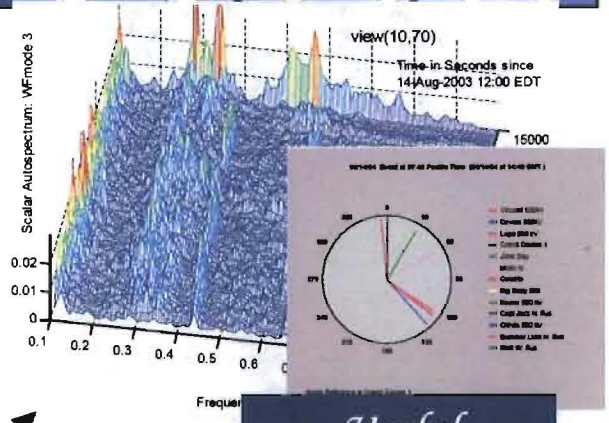
- Automating Demand Response
- AMI
- Dynamic Rates
- Home Area Networks
- Plug in Hybrids
- Renewables

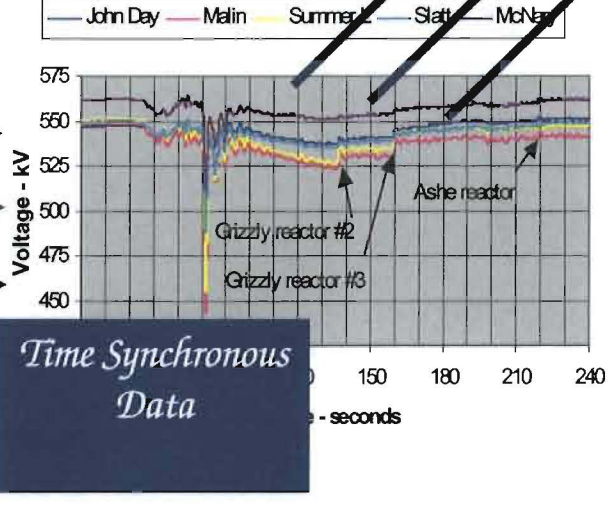
Why Smart Grid

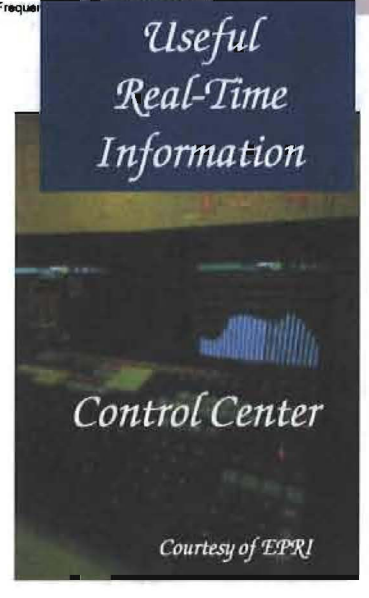
- Improved Grid Operations
  - Higher reliability
  - Less outage time / shorter outages / smarter decisions
  - More options to meet future needs
- Cleaner, Lower Costs Operations, More Efficient
  - New costs lowering technologies
  - Increased efficiency in operating existing systems
  - Meet needs with more environmentally preferred options
  - Higher utilization rates of installed systems
- More Options for Consumers
  - Lower overall energy costs
  - More choices on how to meet individual consumer needs
  - Dynamic rates to better integrated needs of grid and consumer
  - New technologies provide new demand side options

Transmission Research - Phasor Technology









Storyline: Real Time Phasor System from Concept to Control Room

DR as Spinning Reserve

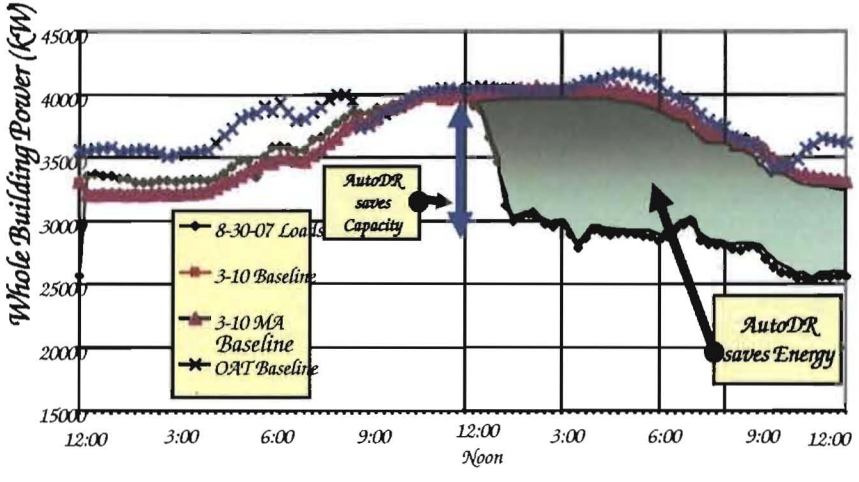
Automated Demand Response

Auto-DR 2007 Results

	2006	2007*
Total Participants	13 CPP	37 CPP 53 DBP 62 CBP 152 Total
Total Base load	8 MW	80 MW
Total Peak Load Reduced	1 MW	25 MW
Average Peak Load Reduction	13 %	34%

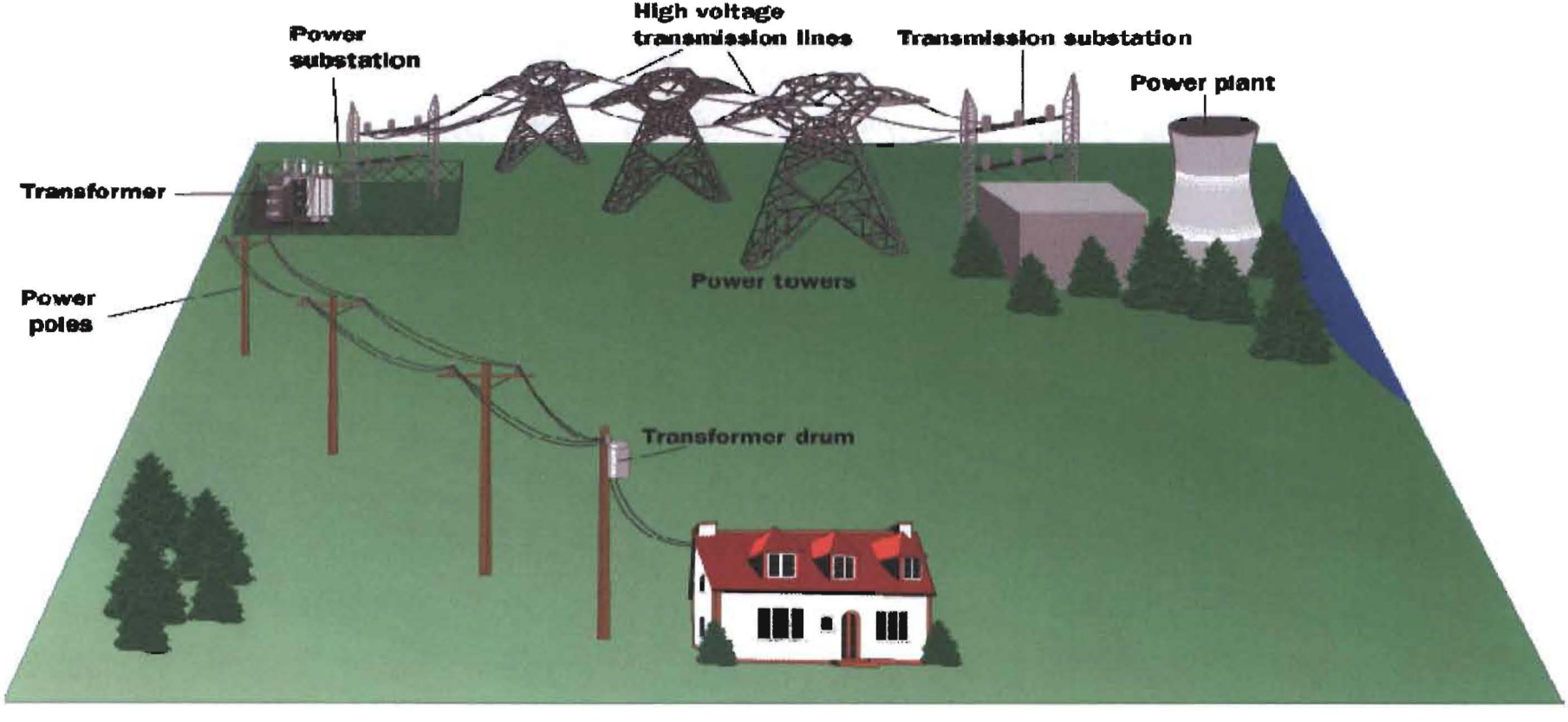
* *Includes large industrial loads.*

PG&E AutoDR Test Day – All AutoDR Participants – 8/30/07



Grid Security

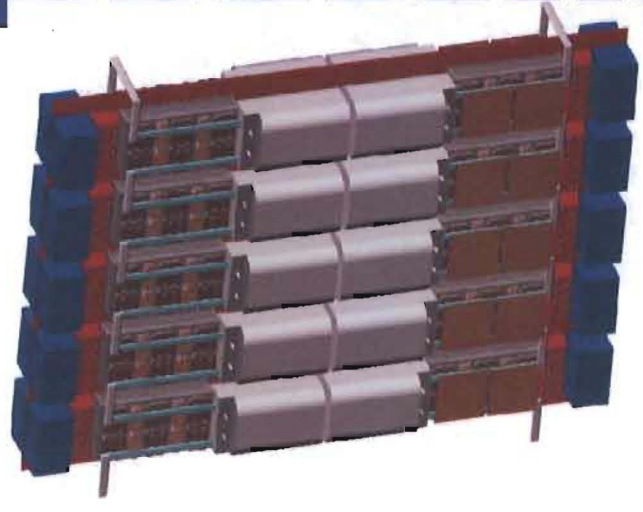
Strategies to Minimize All Hazards Impact on the California Electrical Power Grid



Fault Current Controllers

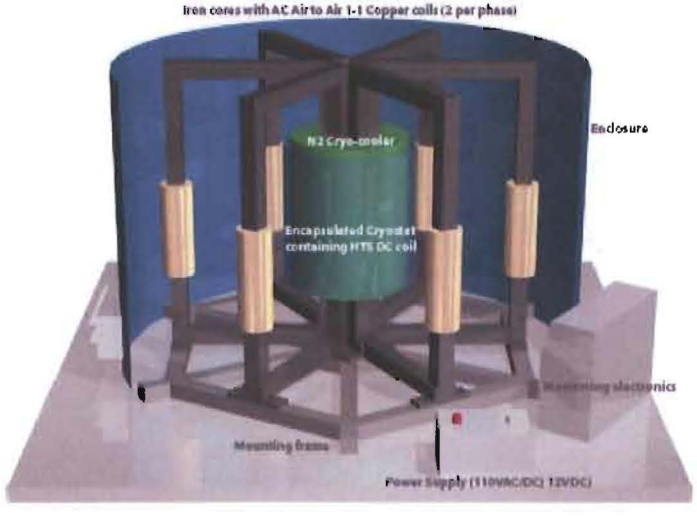
1. EPRI Solid State Fault Current Limiter (SSFCL)

Based on a new generation of advanced thyristor technology. Testing scheduled for mid-2009.



2. SC Power Systems High-Temperature Superconducting (HTS) Fault Current Limiter

HTS elements in combination with a saturable iron core. Testing scheduled for late 2008.



3. Siemens/American Superconductor FCC (Phase 2)

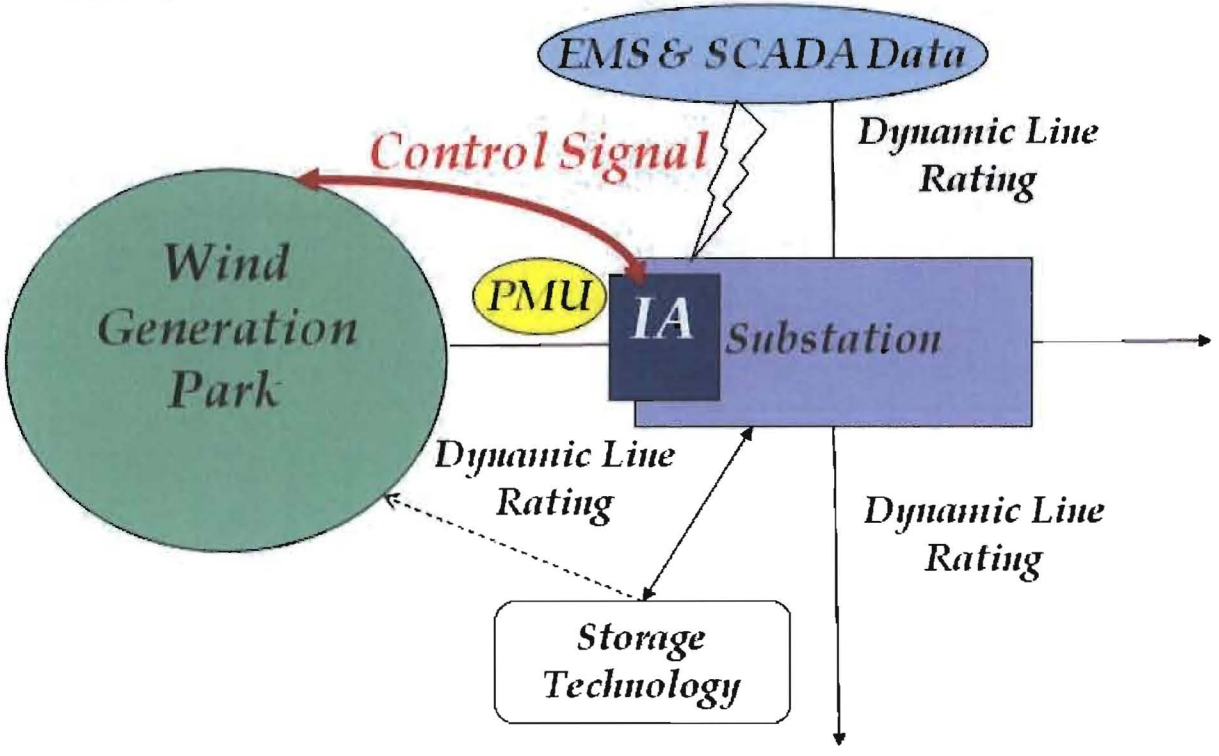
Also an HTS design. Siemens/AS are in negotiations with DOE on project scope, schedule, and funding. Testing scheduled for 2010.

Intelligent Agent Technology

California ISO
Your Link to Power

California Independent
System Operator Corporation

Application of Intelligent Agent



Calculation of Available Transmission Capacity

Energy Storage Technologies

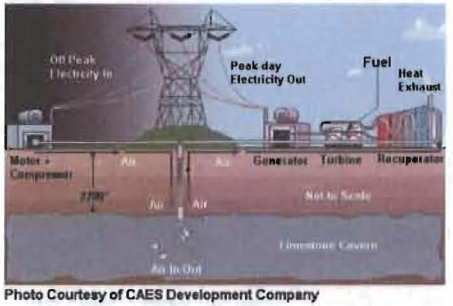


Photo Courtesy of CAES Development Company

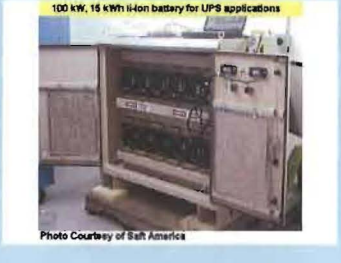
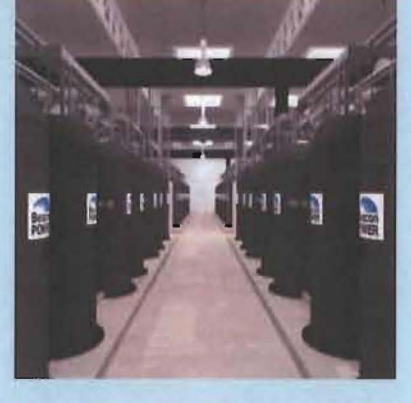
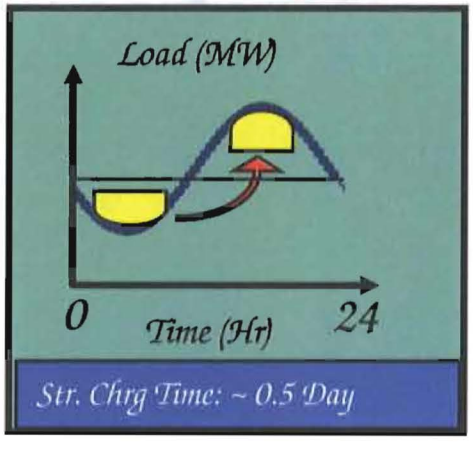


Photo Courtesy of Saft America



Energy Storage Applications

Load Leveling

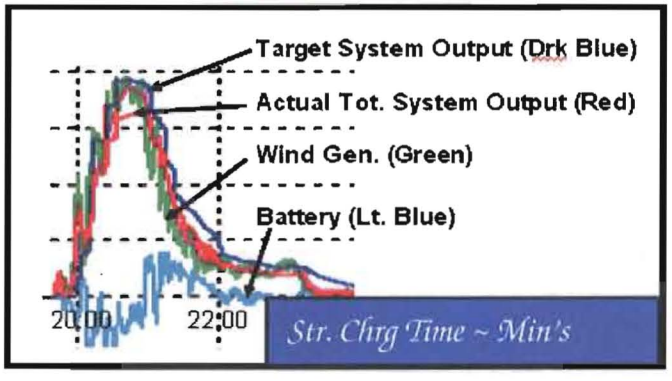


- CAES
- Pumped Hydro

Ramping:

- CAES
- Pumped Hydro
- Battery, Flow type
- Note: In California ramping is a big issue

Frequency Regulation:

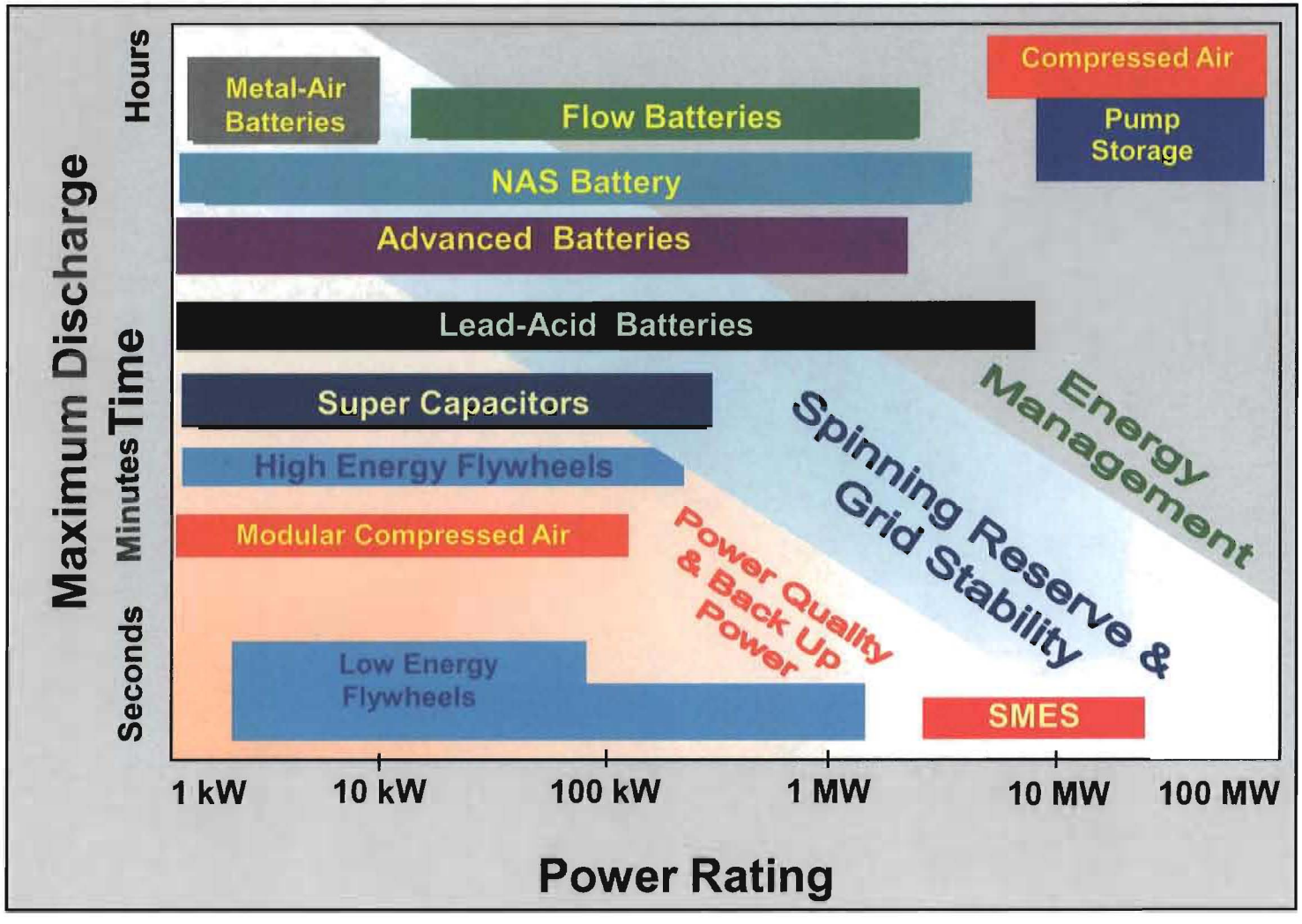


- Battery, Regular or Flow Type
- SuperCap
- Flywheel
- SMES

Energy Storage Technologies

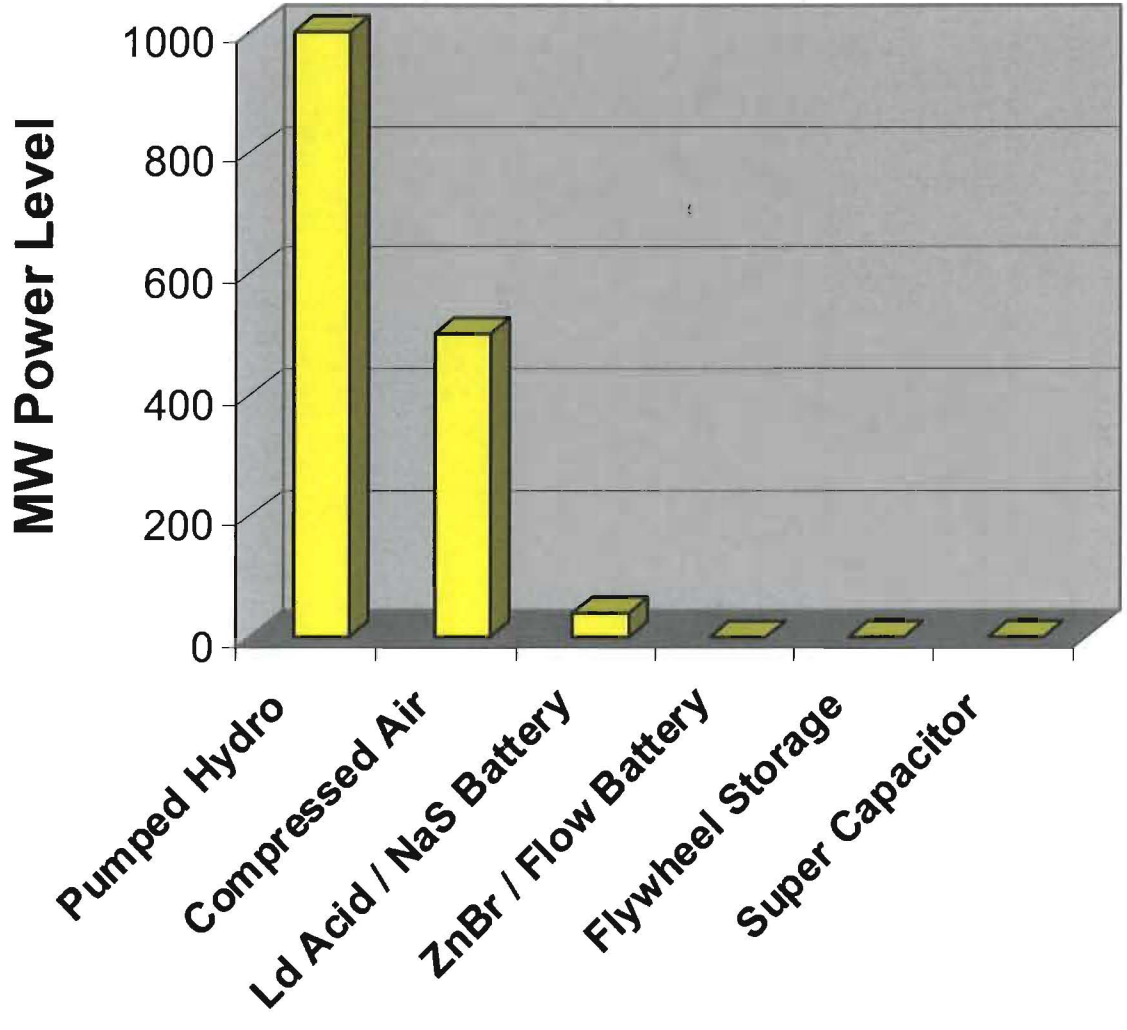
- Pumped Hydro
- Compressed Air Energy Storage (CAES)
- Flywheels
- Batteries
- Super-Capacitors (SuperCaps)
- Superconducting Magnetics
- Thermal Storage
- Fuel Cells (reversible)
- Hydrogen Storage

Energy Storage Technologies

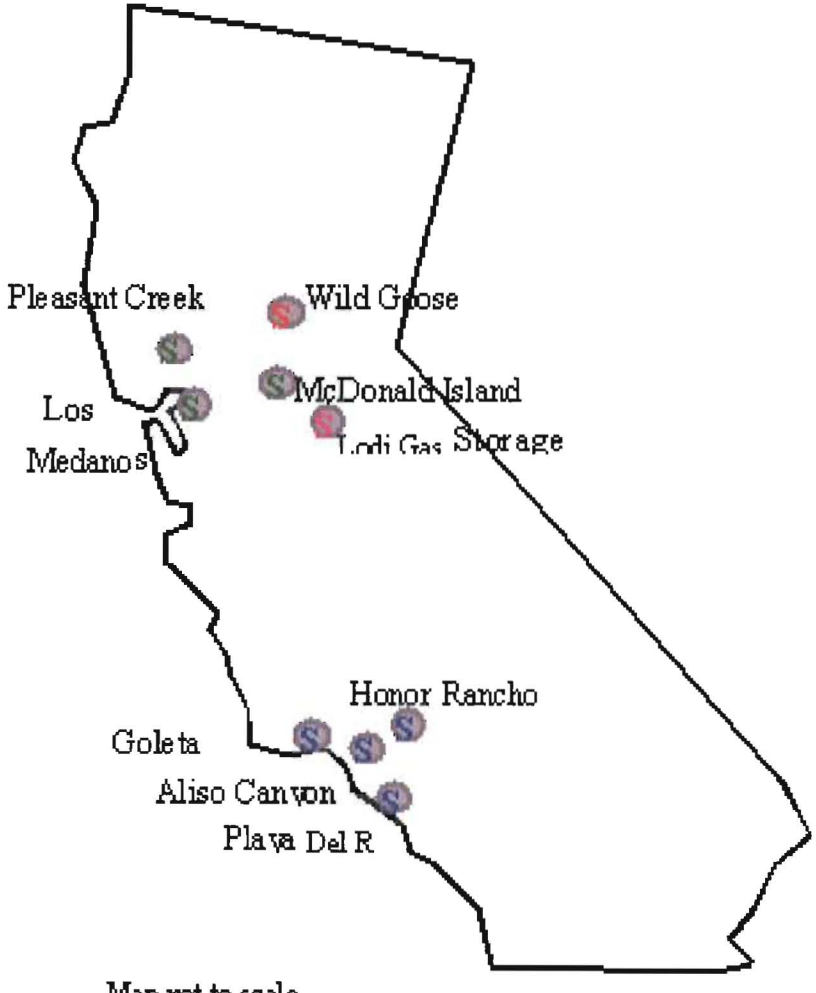


MW Capability Of Energy Storage Plants (In Next Five Years)

MW Power Scale Per "Module" For Energy Storage Plant Types

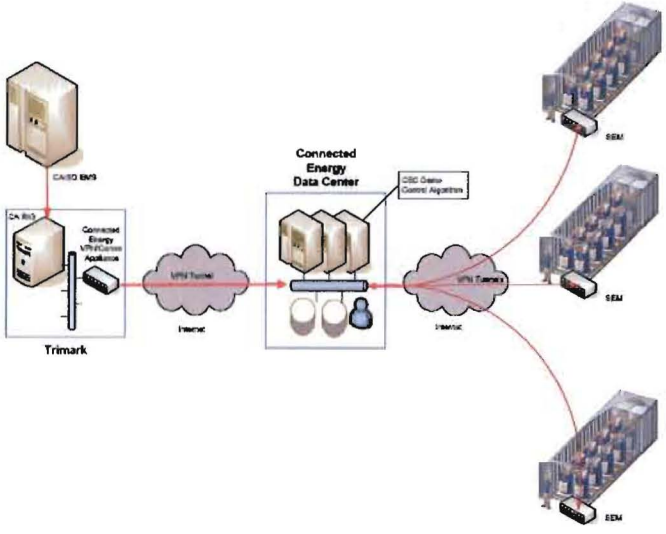


CAES Geologic Siting Opportunities In California



Map not to scale
Source: California Energy Commission

Energy Storage Research
Flywheel Technology

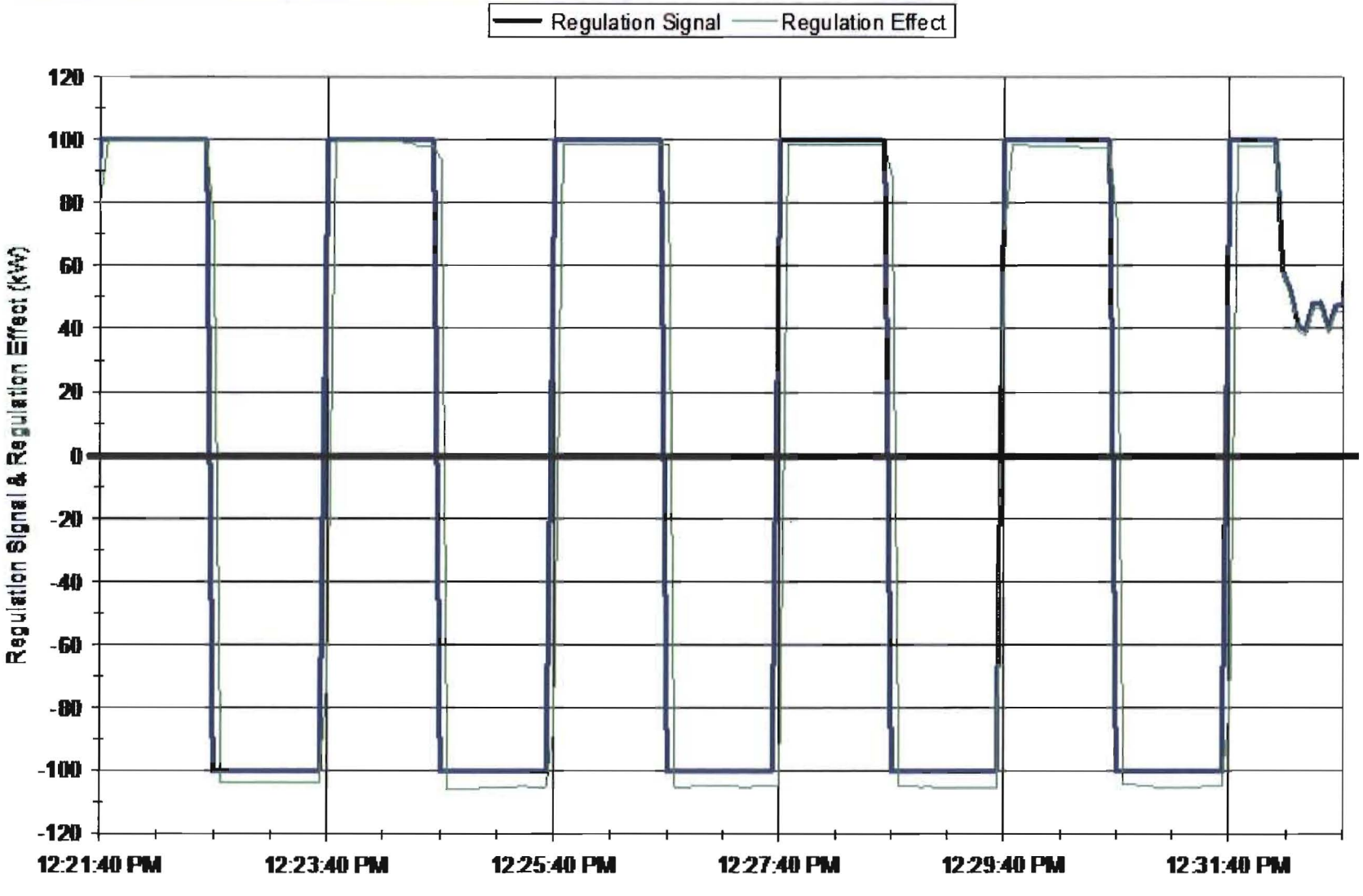


Smart Energy Matrix 20 MW Plant

Artist's rendering of preliminary design

Beacon POWER.

Results – Slam Test

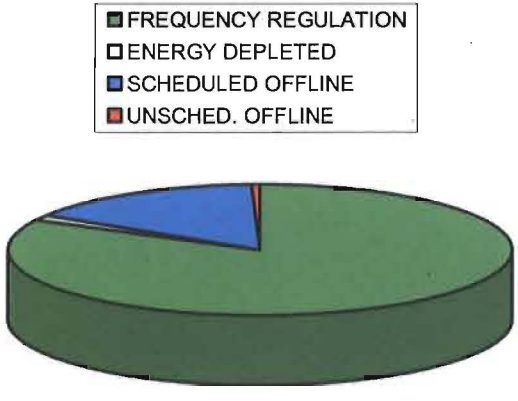


Results - Monthly Performance Summary

CEC Run Data Monthly Summary Sheet **Date: August, 2006**

Beacon Power Proprietary Information

		Percent	Hours
DAILY SUMMARY	FREQUENCY REGULATION	86%	20.5
	ENERGY DEPLETED	1%	0.3
	SCHEDULED OFFLINE	12%	2.9
	UNSCHED. OFFLINE	1%	0.2
	Total	100%	24.0
ON-LINE PERFORMANCE	Availability = Freq Reg / 24 Hrs minus Scheduled Offline Hrs	97.6%	
	Deviation Excluding Depleted Time	2.2%	
	Deviation Including Deplete Time	3.1%	



Open Discussion