Energy Commission

Emerging Technology Research

Michael Gravely
Manager
Energy Systems Research Office
California Energy Commission
mgravely@energy.state.ca.us / 916-651-0316

Potential R&D Outcomes from Today's Workshop

- **Clarification and better understanding of current emerging technology efforts and activities**
- **Future load management standards and or directives that result in new RD&D needs**
- **New RD&D topics or areas of interest that evolve from follow-on discussions and activities**

ET Research Ongoing at all Levels

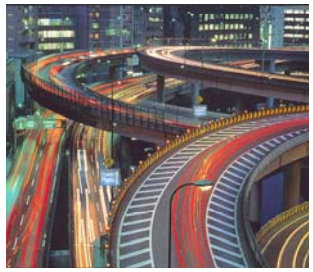
Transmission

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

Distribution

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

Integration

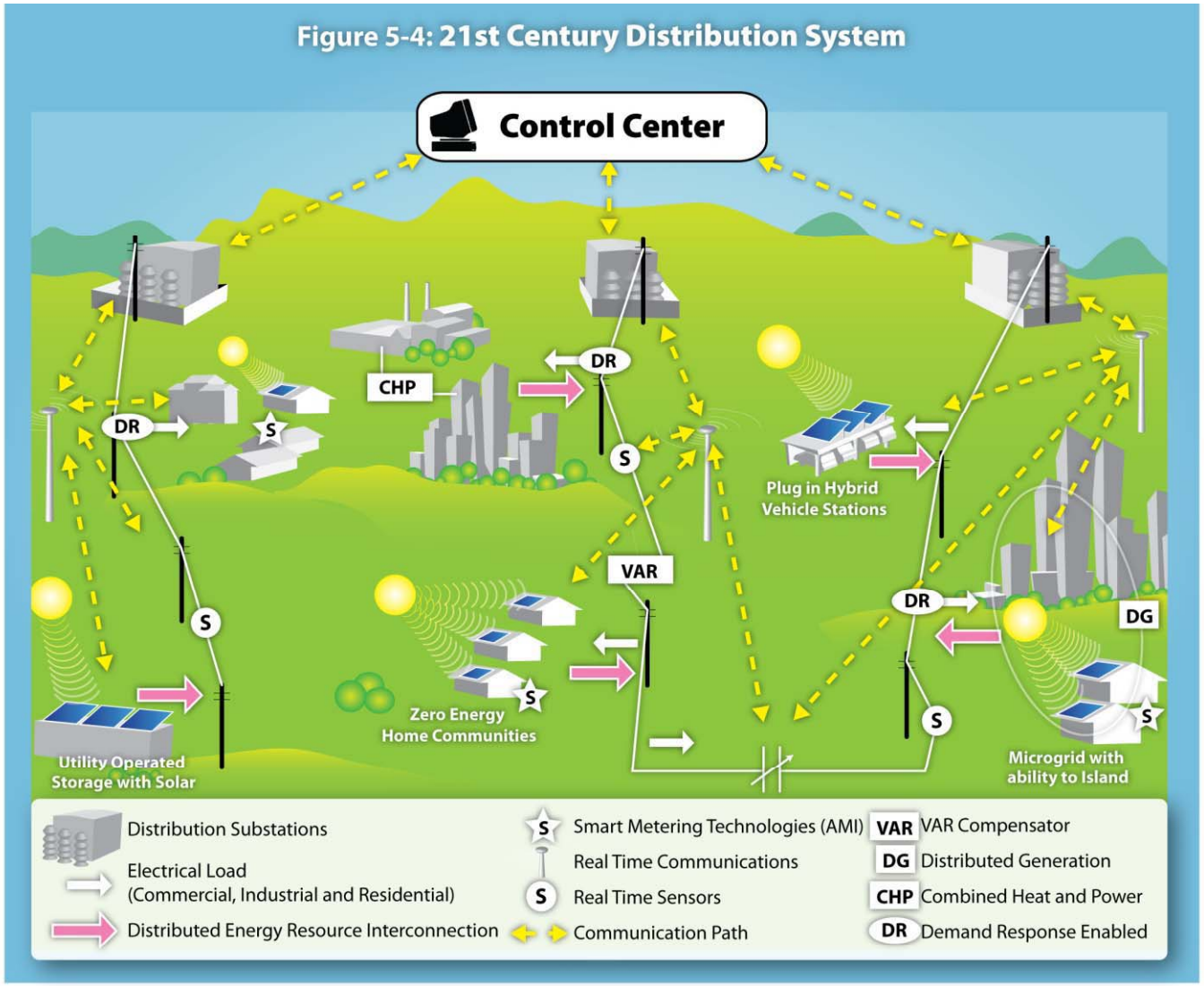


- Renewables
- Standards
- Protocols
- Reference designs
- Micro Grids
- Automation

Consumer

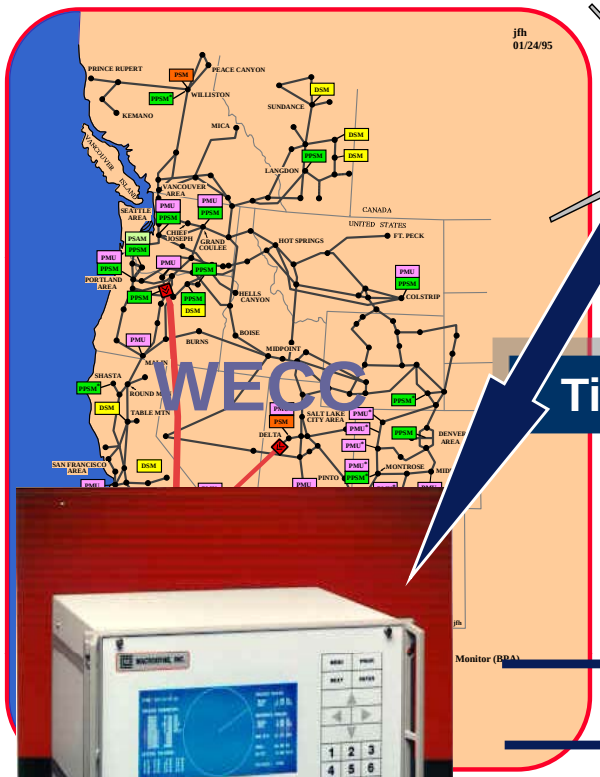
- Automating Demand Response
- AMI
- Dynamic Rates
- Home Area Networks
- Plug in Hybrids
- Renewables

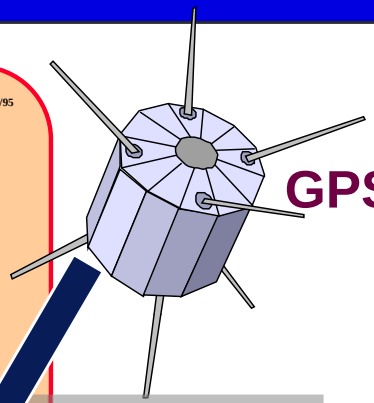
Utility Grid of the Future (Smart Grid)



Source: 2007 Integrated Energy Policy Report

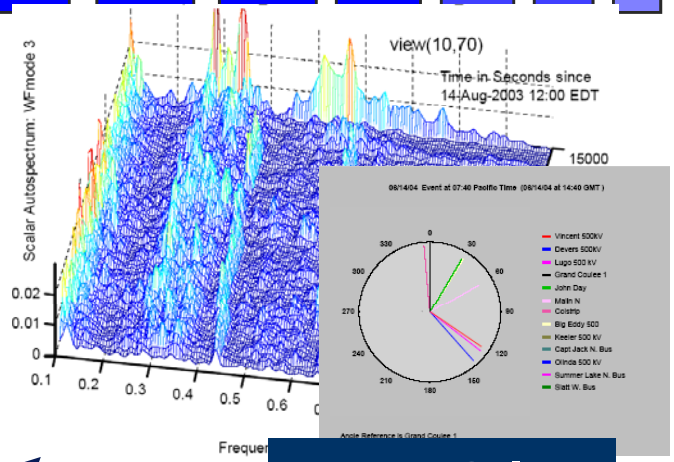
Transmission Research—Phasor Technology



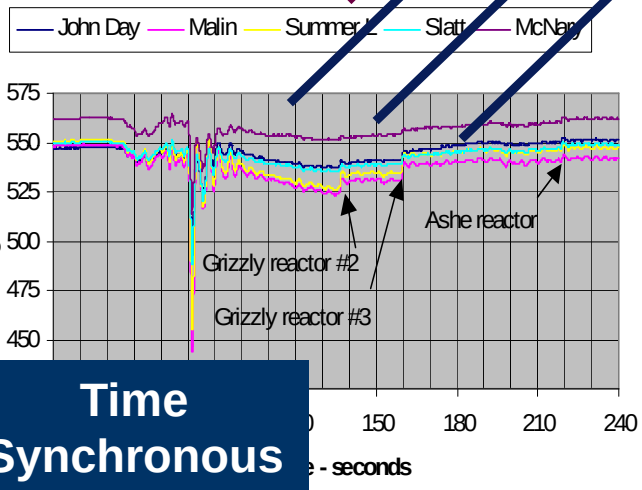


GPS Satellite

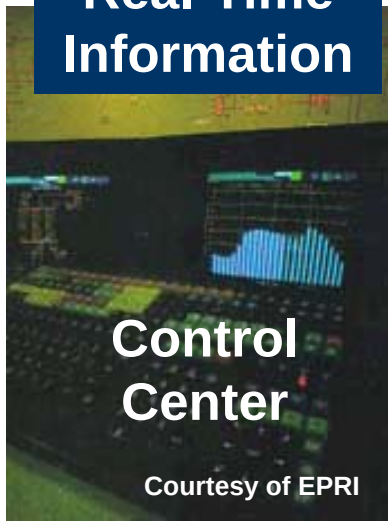
Time-Stamp



Data



Useful Real-Time Information



PMUs (Phasor Measurement Units)

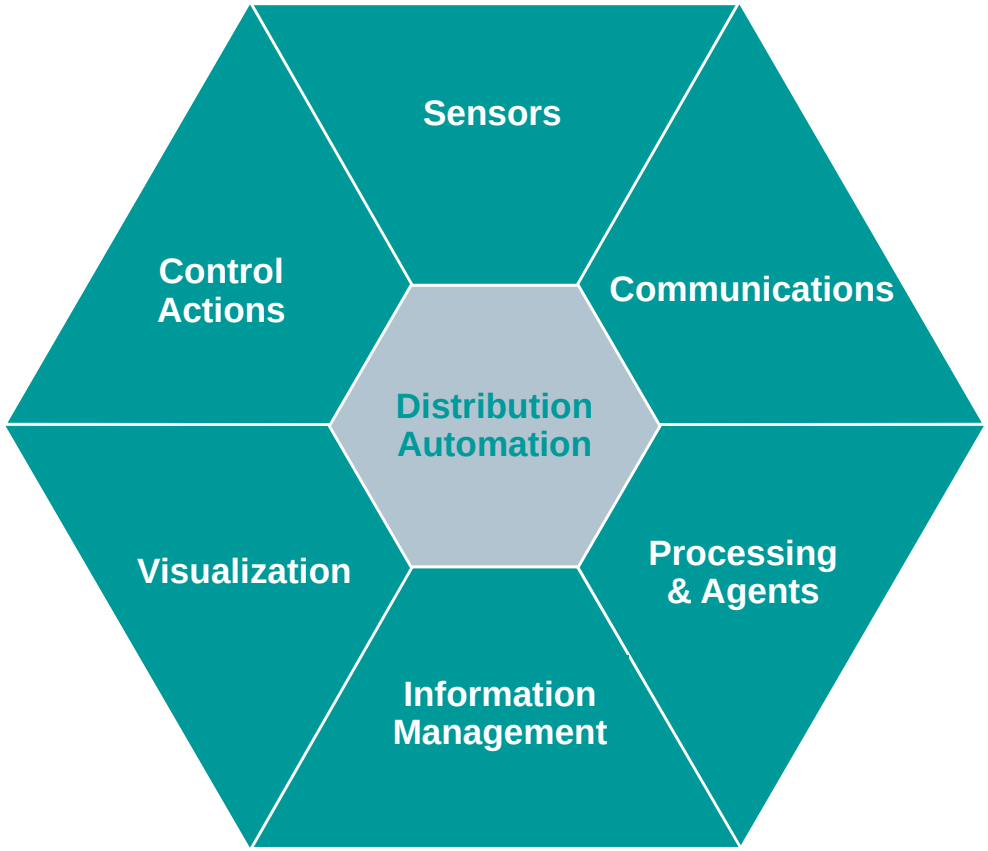
Data

Time Synchronous Data

Storyline: Real Time Phasor System from Concept to Control Room

Distribution Automation Research

Distribution Automation is a family of technologies that can perform certain distribution system operations with reduced human contact and involvement.



Sensors
- Underground cable condition detection
- Low impact fault detection

Communications
- PV/utility communications
- New/legacy equipment interface

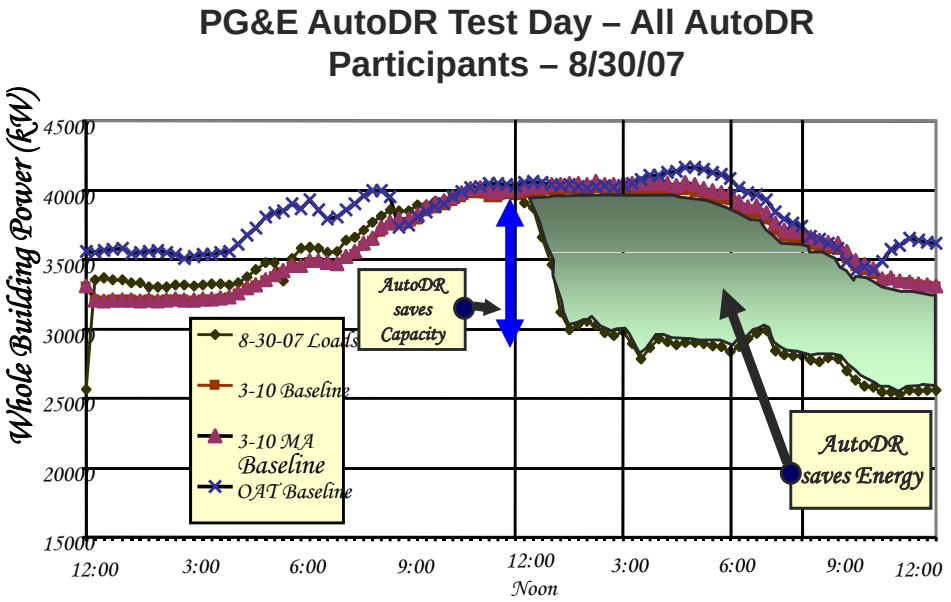
Information Management
- DER information model and communications
- Renewable Data Integration/Standards (61850)

Multiple Areas
- Value of DA Study
- Utility-scale Smart Grid Demonstrations (micro-grids)

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.*

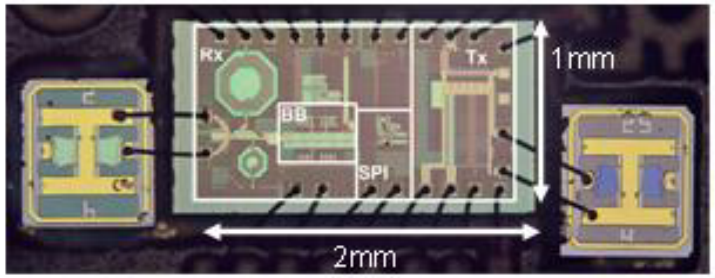


DR as Spinning Reserve or Ancillary Service

Emerging Technologies--Communications

Recent Enabling Technology Development Research Projects

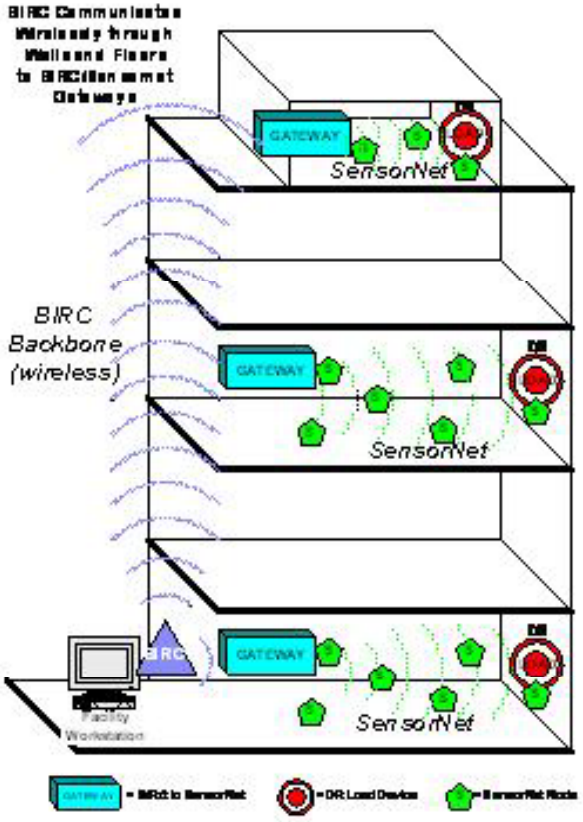
Smaller, cheaper radio components…



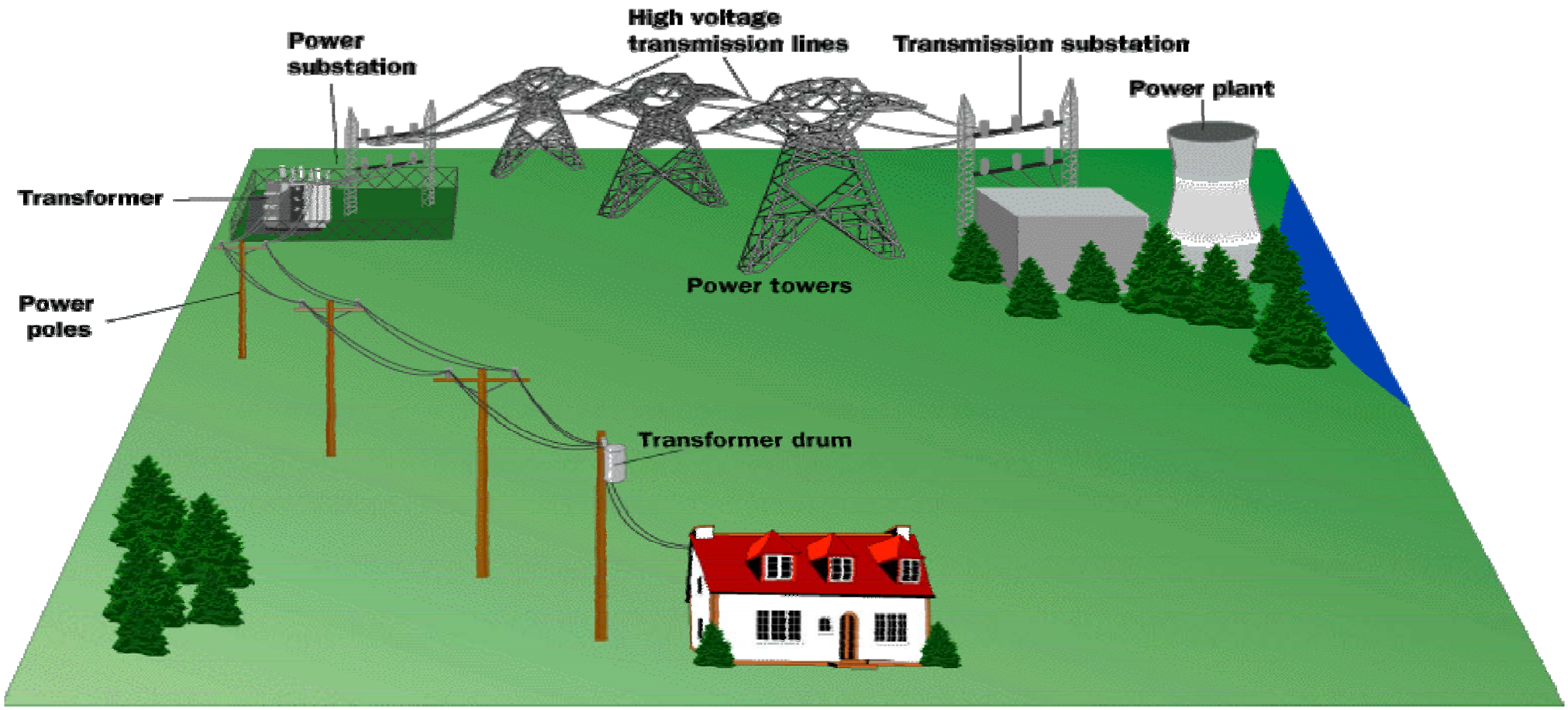
… leads to smaller, cheaper DR enabling technologies

Barrier Immune Radio Communications

Studying how different communication signals propagate through different building materials.



Grid Security



Energy Storage Technologies

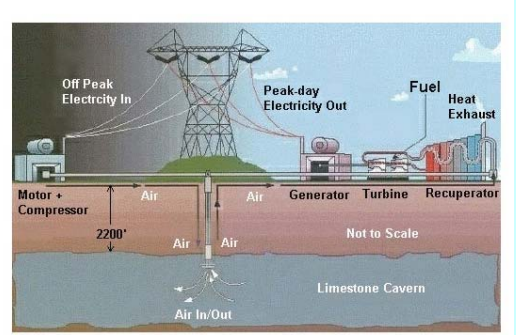
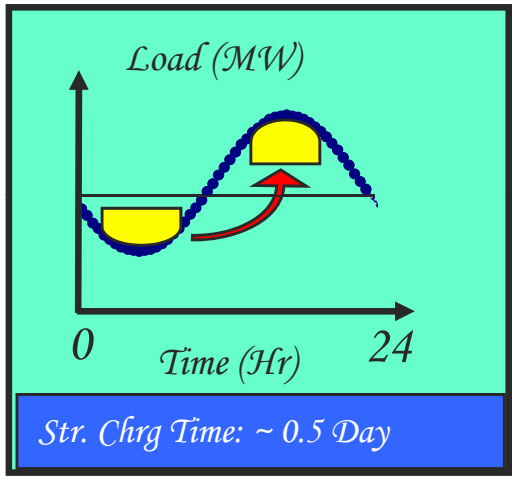


Photo Courtesy of CAES Development Company

Photo Courtesy of Saft America

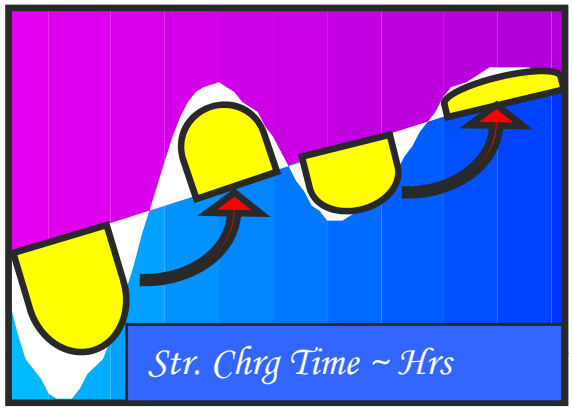
Energy Storage Applications in California

Load Leveling



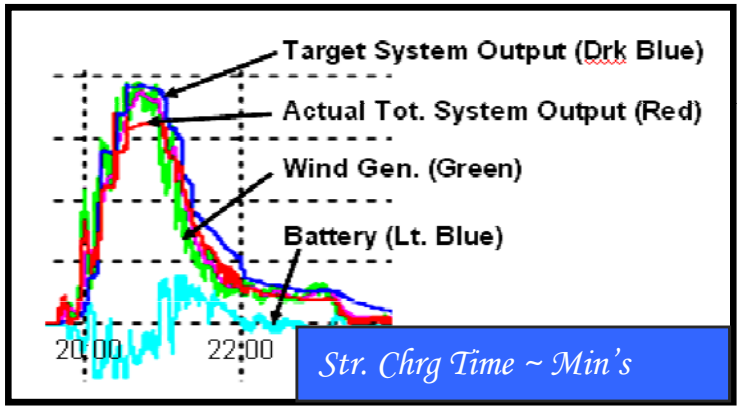
- CAES
- Pumped Hydro

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

Capital Cost Comparison of Energy Storage Plant Types

Technology	$/kW	+	$/kWH*	x	H	=	Total Capital, $/kW
Compressed Air, CAES							
- Large (100-500 MW)	440		1		10		450
- Small (10-20MW) AbvGr Str	600		80		2		760
Pumped Hydro, PH							
- Conventional PH (1000MW)	1300		40		10		1700
Battery, BES (target) (10MW)							
- Lead Acid, commercial	250		300		2		1150
- Advanced (NaS/Flow)	250		500		2		1250
Flywheel (target) (100kW)	250		700		2		1650
Superconducting (1MW)	200		1000		2		2200
Magnetic Storage, SMES (target)							
Super-Capacitors (best today)	250		12000		1/60		450
(target)	250		1200		1/60		270

* This capital cost is for the storage "reservoir", expressed in $/kW for each hour of storage. For battery plants, costs do not include expected cell replacements. EPRI updates these plant costs as technology improvements occur.

Future Energy Storage Research

- **Developing energy storage operational envelops for use with CA SIO Ancillary Services**
  - **Help remove obstacles for use of energy storage technologies**
- **Assessing value of energy storage to the integration of renewables in California**
- **Assessing use of energy storage to permit 24-hour use of renewables in California**
- **Support key energy storage demonstration projects**

Follow-up Questions

Michael Gravely

California Energy Commission

mgravely@energy.state.ca.us

916-651-0316