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Federal Energy Management Program

Automated Demand Response in Large Commercial Facilities

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David S. Watson

Lawrence Berkeley National Lab

watson@lbl.gov

510.486.6255

Presentation Overview

- Definition: Automated DR
- Participating Customers
  - Building Profiles
- Results:
  - Auto-DR System Description
  - Load Curtailments
  - DR Strategies
  - Comfort
- Recommended "Best Practices"
  - State-of-the-Art DR Technology

Definition: Levels of Automation in DR

- Manual DR – **Building operators manually turn off switches and change set points at each device**
  - Labor intensive
  - Poor reliability, repeatability
  - Day ahead notification req'd
- Semi-Automated DR - **pre-programmed DR strategies initiated by a person via centralized control system**
  - Better reliability, repeatability
  - Hours ahead notification req'd
- Fully-Automated DR - **pre-programmed DR strategies automatically initiated upon receipt of remote signal**
  - Most reliable & repeatable
  - Sheds can occur within seconds

Result Summary: Automated-DR Field Tests

- Fast reliable DR sheds in response to Internet based signals
- Used existing Energy Management & Control Systems
- Large sheds can take place without complaints
- Range of strategies required
- Average reduction 8% among 28 buildings, up to 56%

	Number of sites	Avg. Savings (%)	Max. Savings (%)
2003	5	8	28
2004	18	7	56
2005	12	9	38

Building Profiles (1 of 2)

GSA, Phillip Burton Federal Building
Federal (San Francisco)
Office
1,424,000 ft²
2,130 kW peak
GSA, Ronald Dellums Federal Building
Federal (Oakland)
Office
978,000 ft²
4,100 kW peak
GSA, National Archive & Record Admin.
Federal (San Bruno)
Archive storage
238,000 ft²
280 kW peak

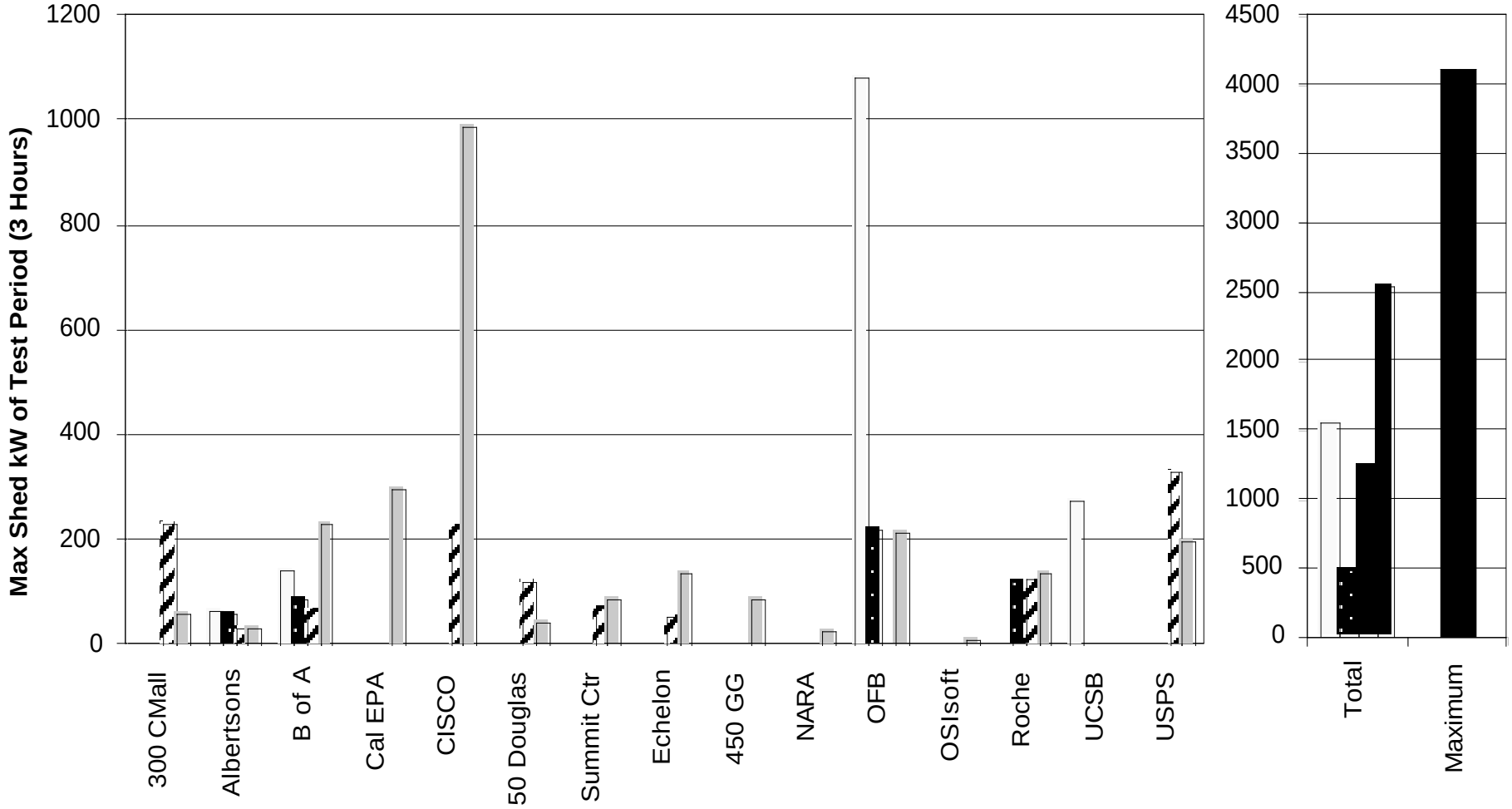
US Postal Service San Jose PDC
Federal (San Jose)
Process, distribution
390,000 ft²
1,630 kW peak
Joe Serna Jr. Cal EPA Headquarters Building
State (Sacramento)
Office
950,000 ft²
1,990 kW peak
UC Santa Barbara Davidson Library
State (Santa Barbara)
Library
289,000 ft²
1,090 kW peak

Results: Building Profiles (2 of 2)

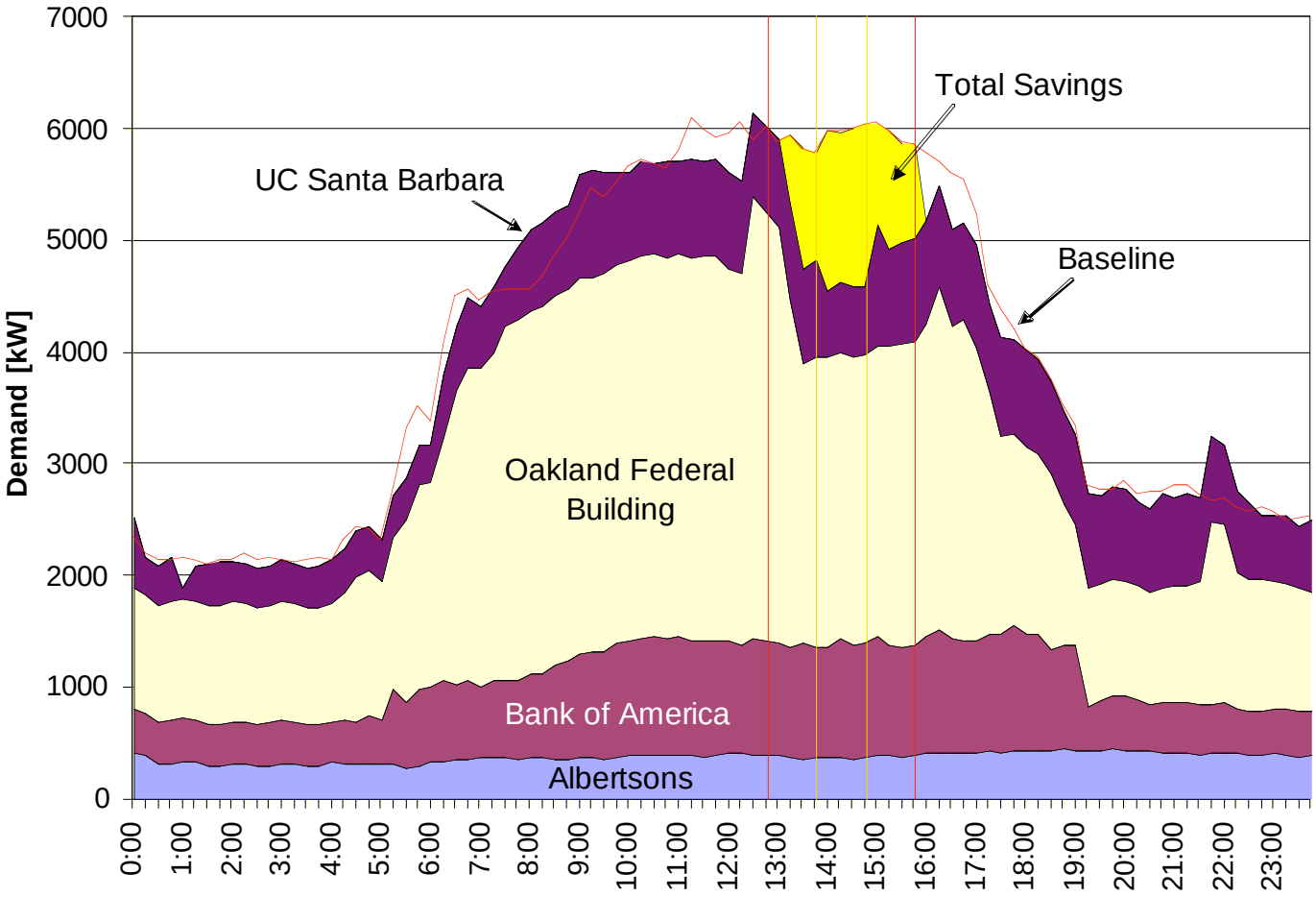
	Contra Costa County 50 Douglas Dr. **County (Martinez)** **Office** **90,000 ft²** **422 kW peak**
	Contra Costa County 2530 Arnold Dr. **County (Martinez)** **Office** **131,000 ft²** **528 kW peak**

	Alameda County Water District **County (Fremont)** **Office, lab** **51,200 ft²** **347 kW peak**
	Cisco Systems Headquarter **Private (San Jose, Milpitas)** **Hi-tech manufacturer** **4,466,000 ft² (24 bldgs)** **27,860 kW peak**

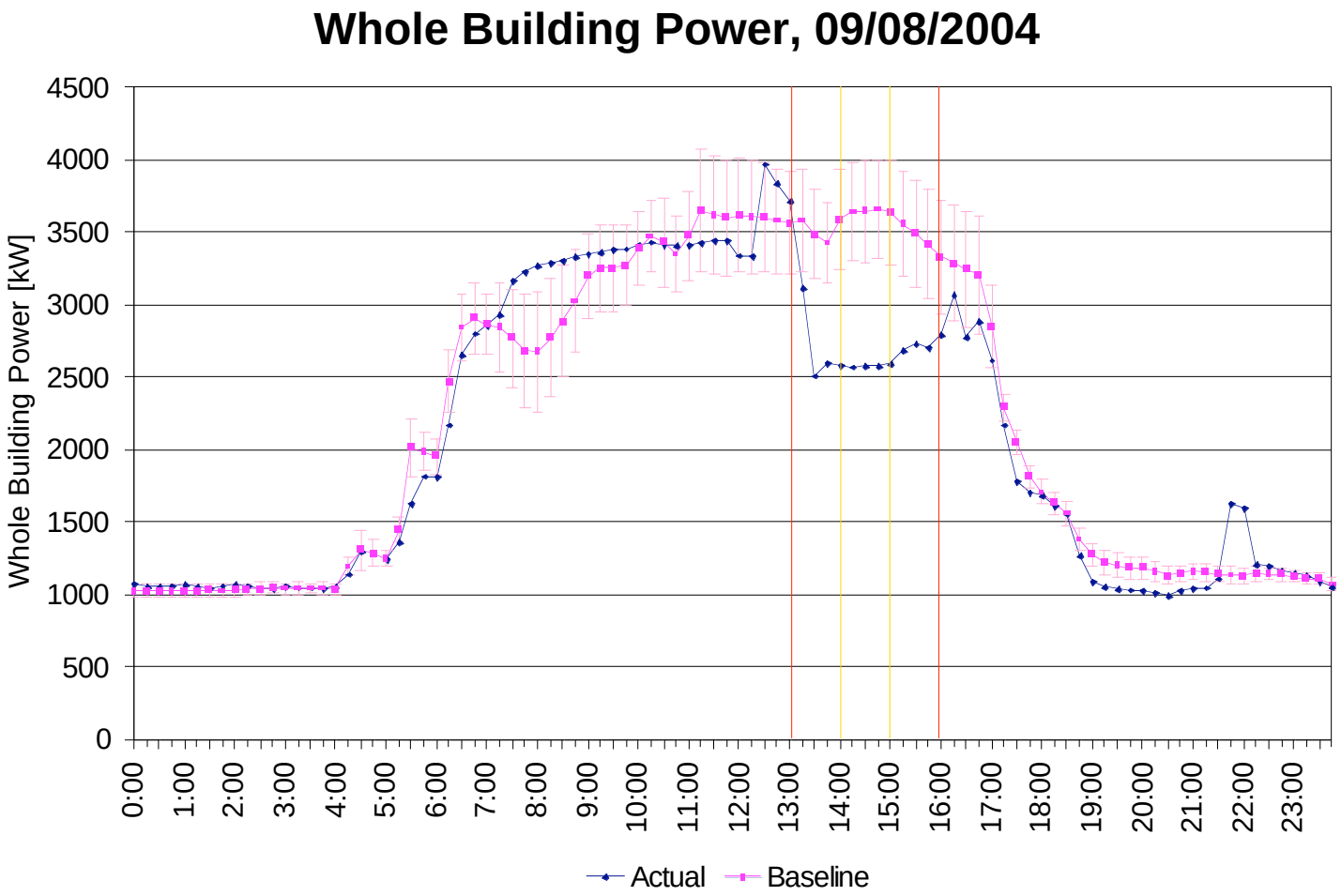
Results: Four Tests in 2004
4 MW Total **(1 of 4)**



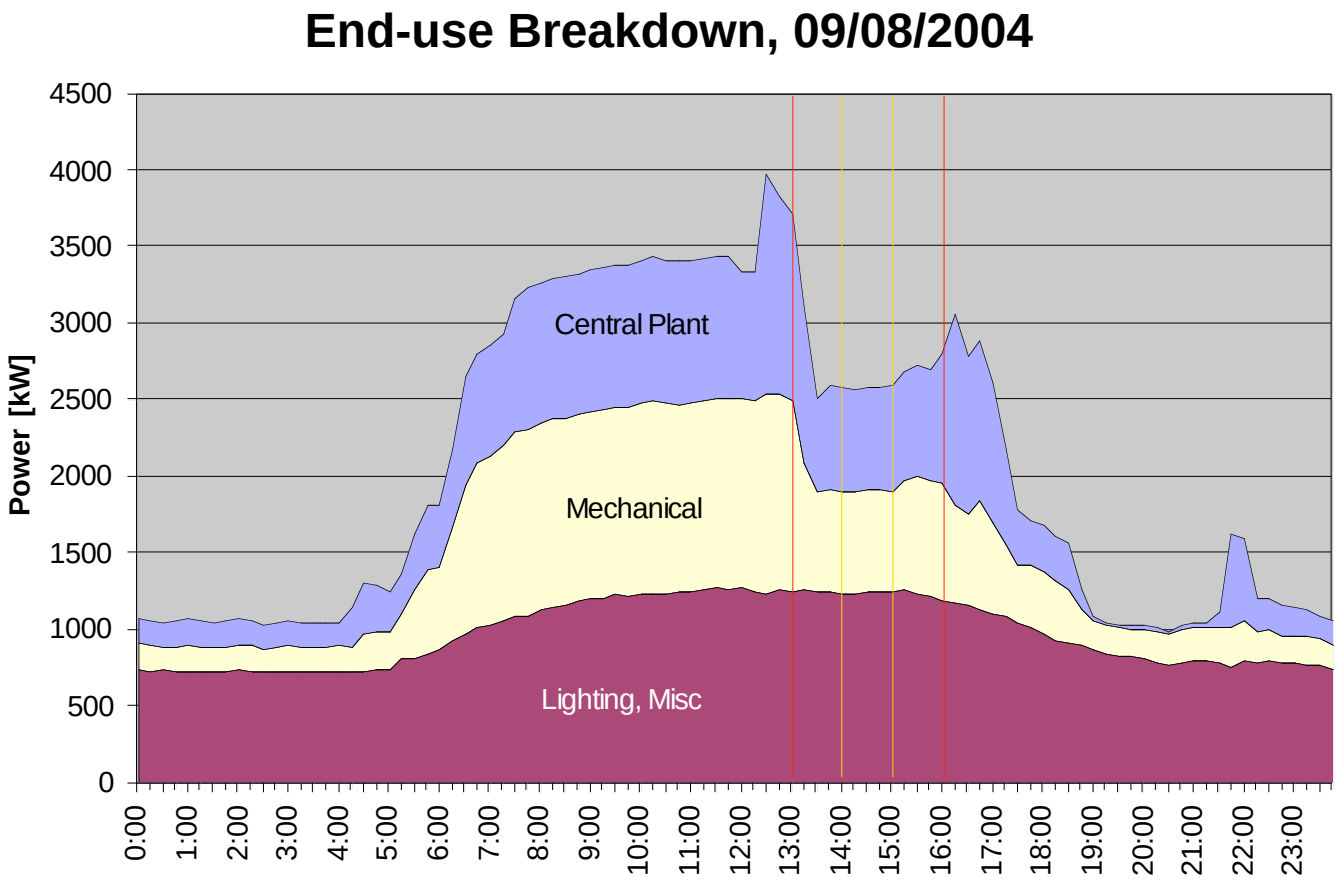
Results: Aggregated Demand Saving Profile September 8th, 2004 (**2 of 4**)



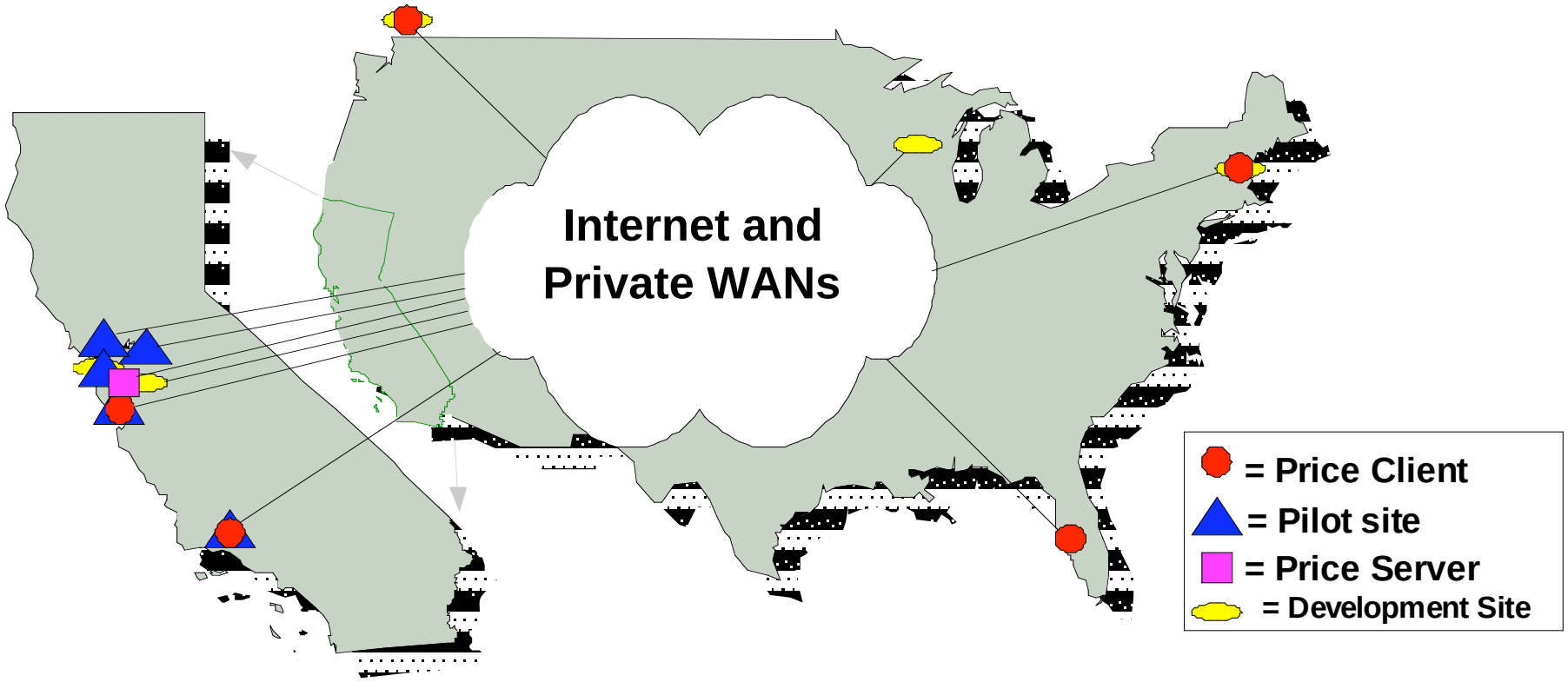
Results: GSA Ronald V. Dellums Federal Building Oakland, CA (GSA) **(3 of 4)**



Results: GSA Ronald V. Dellums Federal Building Oakland, CA (GSA) **(4 of 4)**



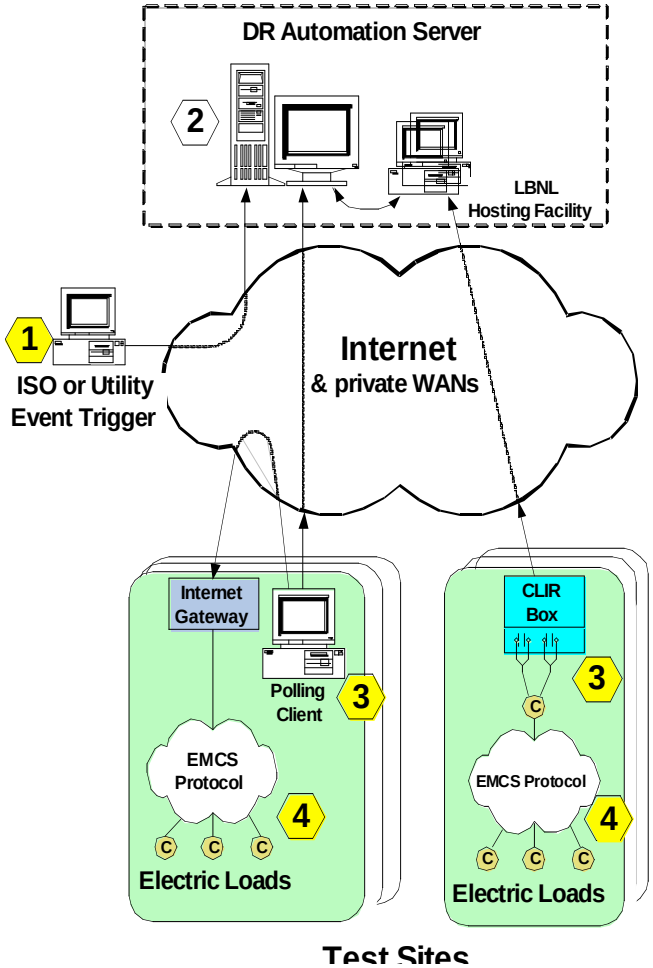
Auto-DR System - Geographic Distribution (1 of 5)



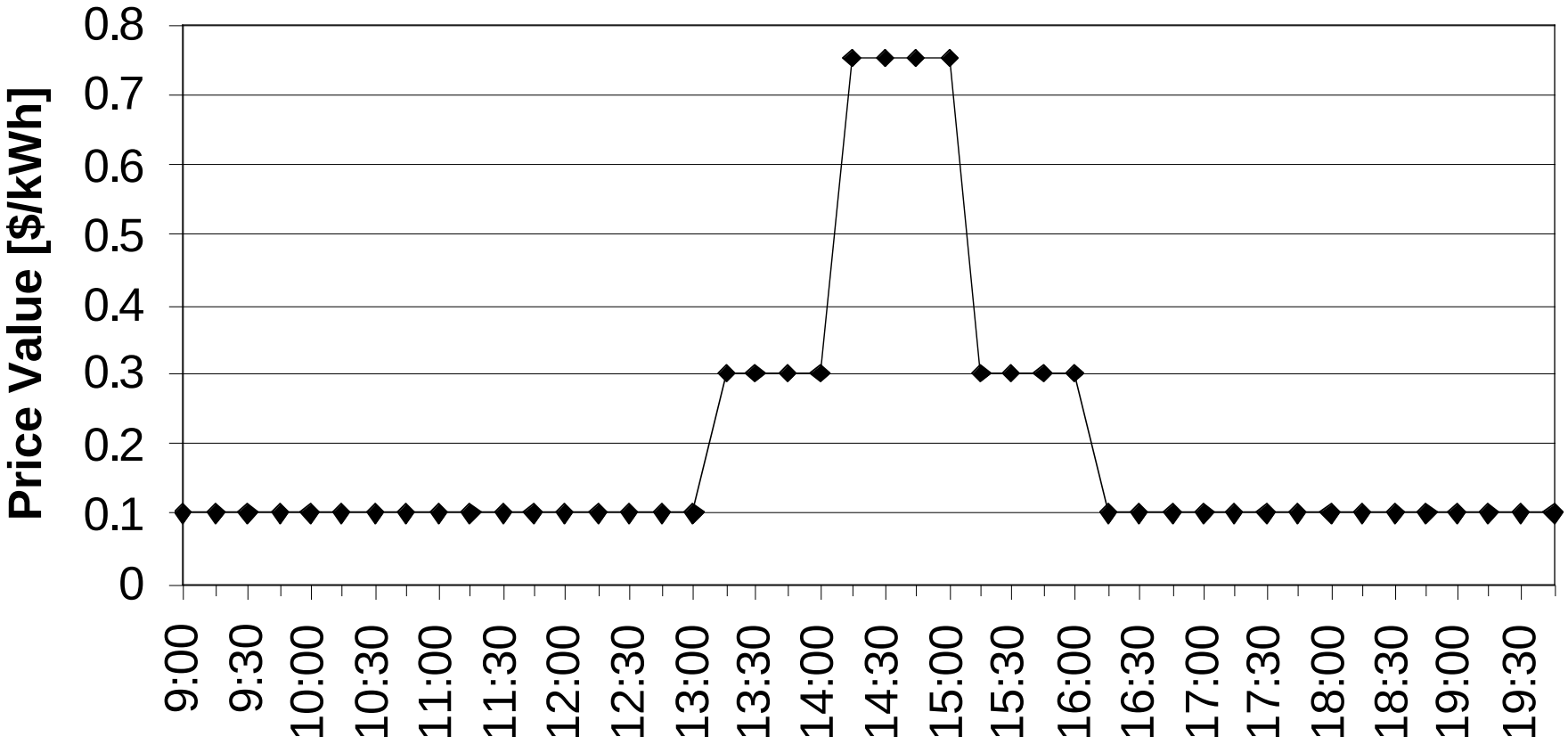
- **Auto-DR infrastructure nationwide**

Auto-DR System: Communications (2 of 5)

- ISO or Utility defines price or mode
- Price/mode published on Automation Server
- Sites automatically check price/mode every minute & send shed commands
- EMCS carries out shed

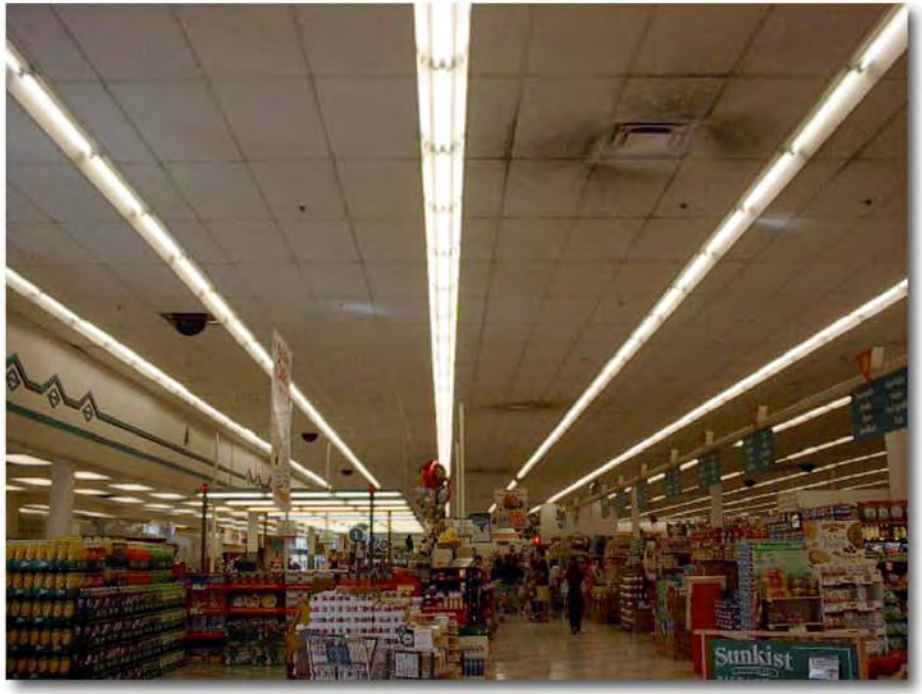


Auto-DR System: Fictional Price Signal – Nov. 19, 2003 (**3 of 5**)



Auto-DR Systems: Effect of Lighting Load Shed on Store Lighting (**4 of 5**)

Full Lighting



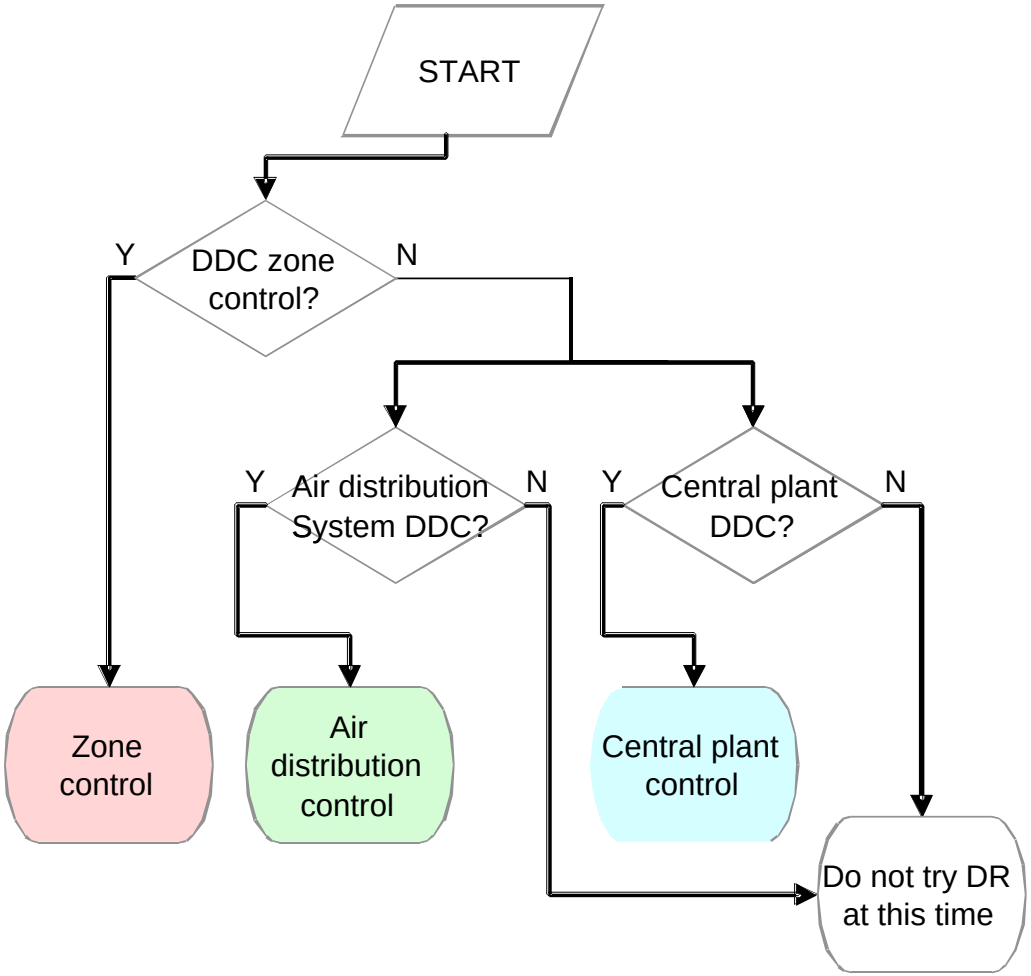
Reduced Lighting during Shed

Auto-DR Systems: Important Attributes (5 of 5)

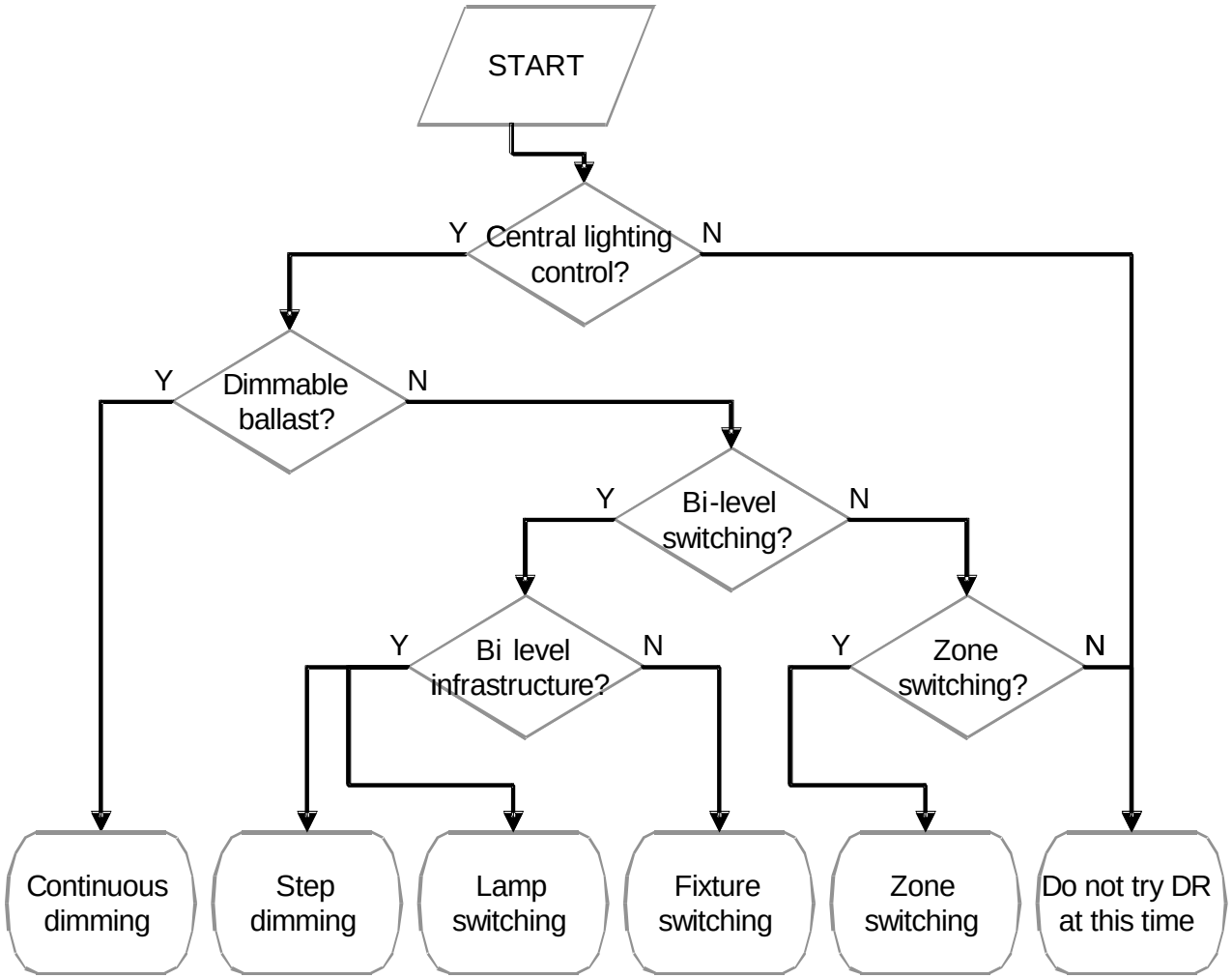
	Albertsons	B of A	GSA	Roche	UCSB
Number of Auto-DRControl points	2	1	~ 1,400	7	42
Shed control points/10,000 sq.ft.	0.4	0.05	10	0.4	1
Control Granularity	Medium	Coarse	Very Fine	Medium	Fine
Closed loop shedControl	Partial	Partial	Yes	No	No

	HVAC											Lighting, misc.				
Strategies (1 of 4)	Zone temperature increase	Supply air temp reset	Fan VFD limit	Fan off	Duct static pressure reset	Cooling valve close	Cooling fan-coil off	Direct chiller limit	Chilled water temp reset	Boiler pump (reheat) off	Electric humidifier off	Common area lighting	Office lighting shed	Anti-sweat heater shed	Fountain pump off	Transfer pump off
Albertsons												✓		✓		
B of A		✓	✓		✓											
GSA Oakland	✓															
Roche				✓												
UCSB Library			✓		✓	✓										
450 GG	✓															
NARA	✓															
Echelon	✓											✓	✓			
Monterey												✓				
300 CapMall	✓		✓	✓					✓						✓	
50 Douglas	✓															
Summit Ctr	✓															
Cal EPA					✓							✓	✓			
Kadent																✓
USPS SJ								✓								
CISCO	✓						✓			✓		✓	✓			
CETC				✓							✓					
OSI Soft	✓															

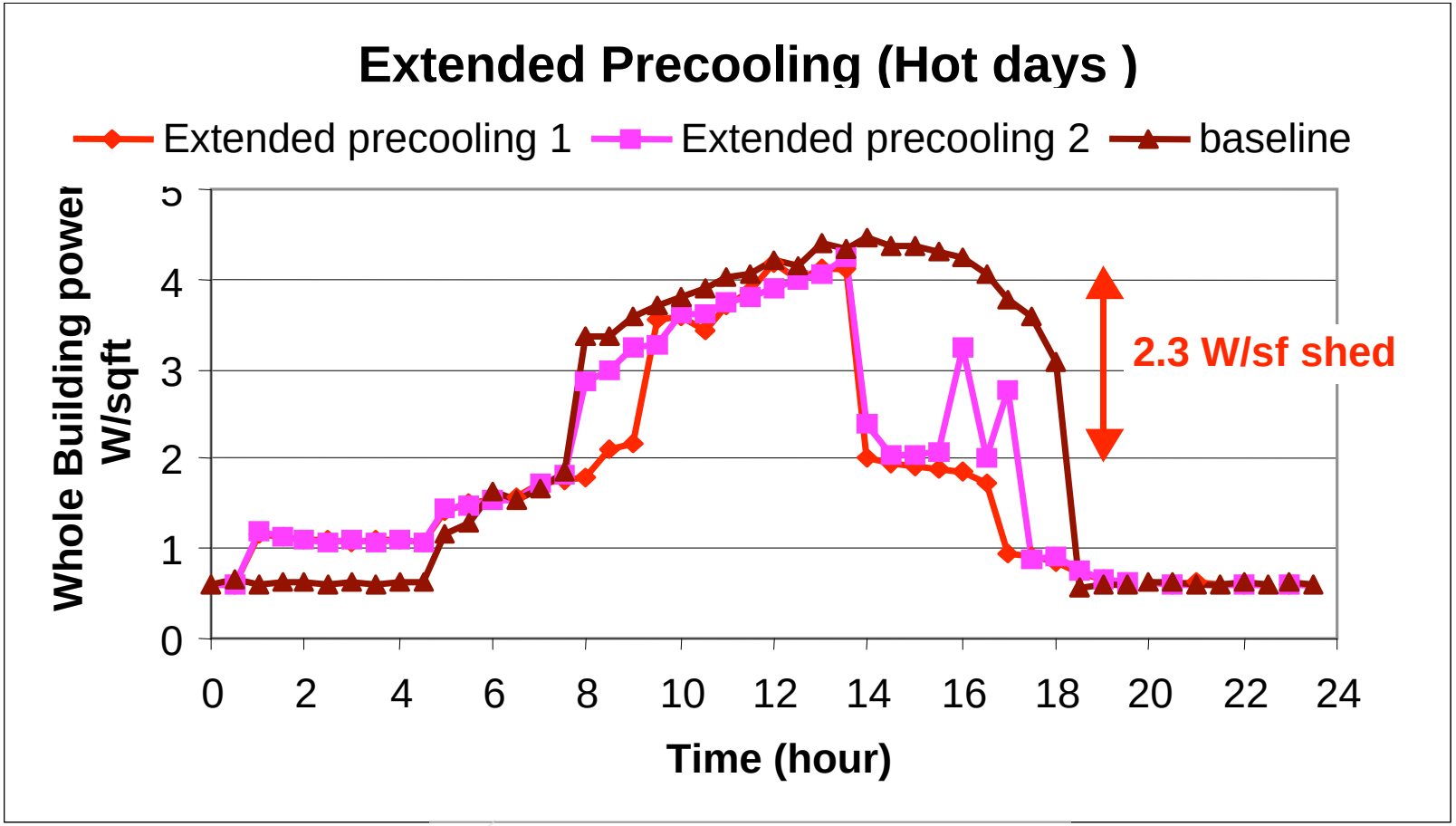
Strategies: HVAC (2 of 4)



DR Strategies: Lighting (3 of 4)



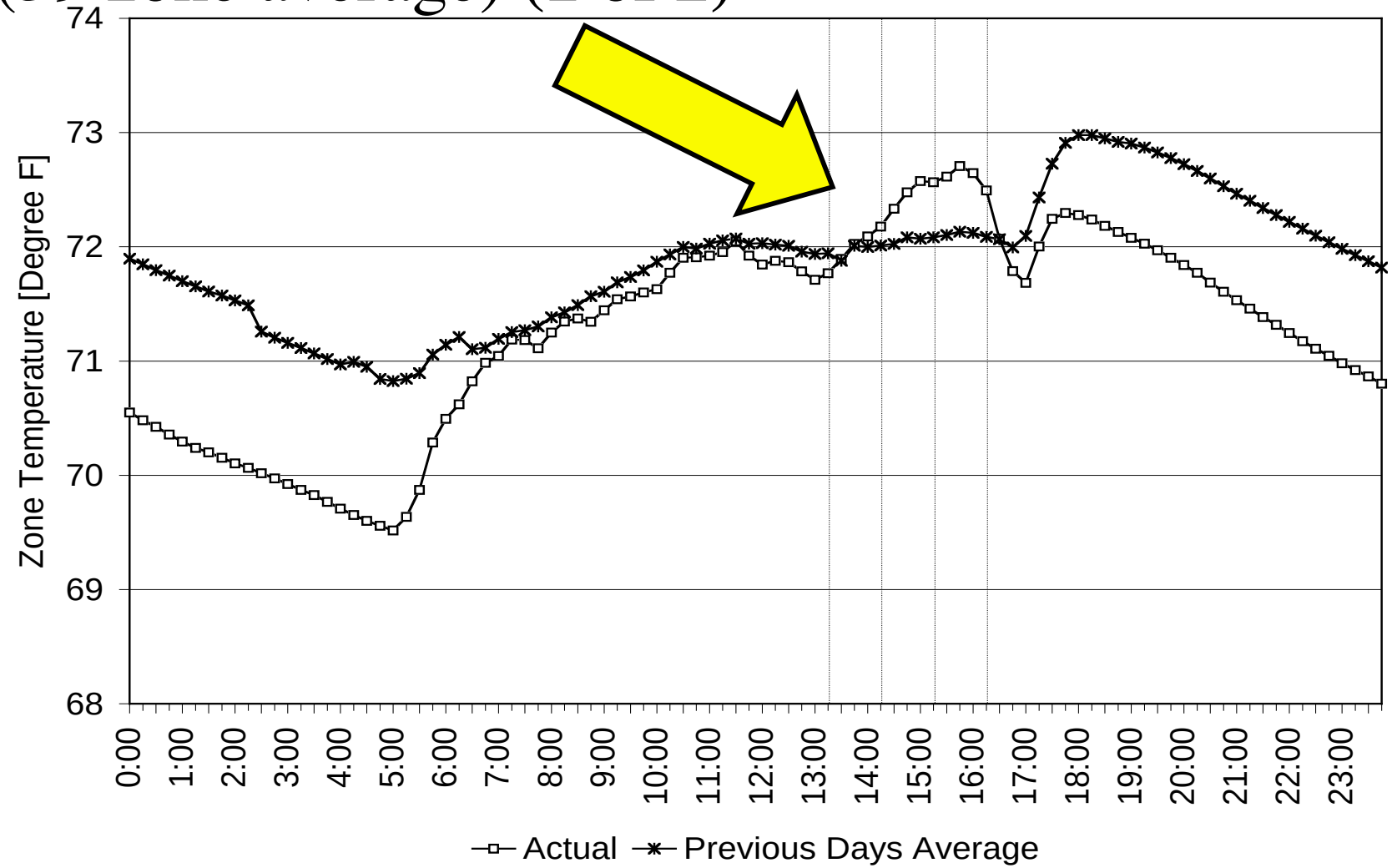
DR Strategies: Pre-Cooling (4 of 4)



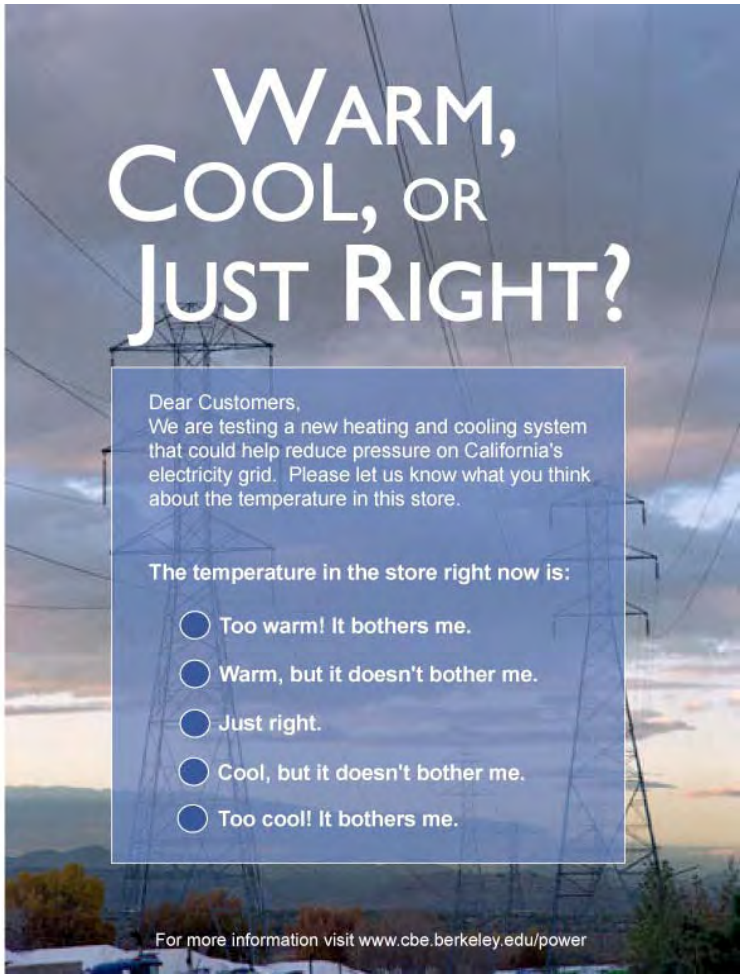
Concrete Floor

Thermal Capacity
~ 3 Watts-Hours/ft^3 - F

Comfort: 1.5 deg. F° Temperature Rise at GSA (39 zone average) **(1 of 2)**



Comfort: Online Tennant Survey (2 of 2)



Auto-DR System Findings: What is State-of-the-Art ?(1 of 5)

The "best" system meets or exceeds the requirements at the lowest installed cost:

Flexible Designs for the Future

- **As future-proof as possible**

Features

- **Customer defined business logic**
- **Customer warnings, alerts & local overrides**
- **Real-time, two-way verification of shed**
- **High security & (shed) availability**

Auto-DR System Findings: What is State-of-the-Art ?(2 of 5)

Leverage Trends in Technology:

- **Internet and private WANs are ideal platforms for Auto-DR controls and communications**
- **Performance of IT equipment (e.g. routers, firewalls, etc.) continues to improve and prices continue to drop**

Auto-DR System Findings: What is State-of-the-Art ?(3 of 5)

Enterprise, EMCS & EIS Integration:

- **EISs and EMCSs should** share the same control network, database and HMI**.**
- **EMCS/EISs networks should be** tightly integrated **with enterprise networks**
- **The most robust and least costly systems should have** no more than 1 enterprise protocol and 1 control protocol

Auto-DR System Findings: What is State-of-the-Art ?(4 of 5)

Open protocol standards should be used:

- **Allows the** *greatest flexibility* **at the** *lowest cost*
- **Truly open systems are** *interoperable*
- *XML alone is not a standard* **for building and energy data. OPC-XML, oBIX, and others are developing XML standards of this type**

Auto-DR System Findings: What is State-of-the-Art ?(5 of 5)

Shed Strategies:

- **Should be designed to** minimize discomfort**, inconvenience, and loss of revenue**
- High granularity closed loop **control are less likely to negatively impact building occupants for a given demand shed**
- **In addition to HVAC control strategies,** lighting and other loads **should be considered for sheds as well**

Questions? Comments?

Further information: LBNL Building Technologies

http://eetd.lbl.gov/BT.html

Dave Watson

510 486-5562

watson@lbl.gov

LBNL Demand Response Research Center

(mngr. Mary Ann Piette)

mapiette@lbl.gov

http://drrc.lbl.gov/drrc.html

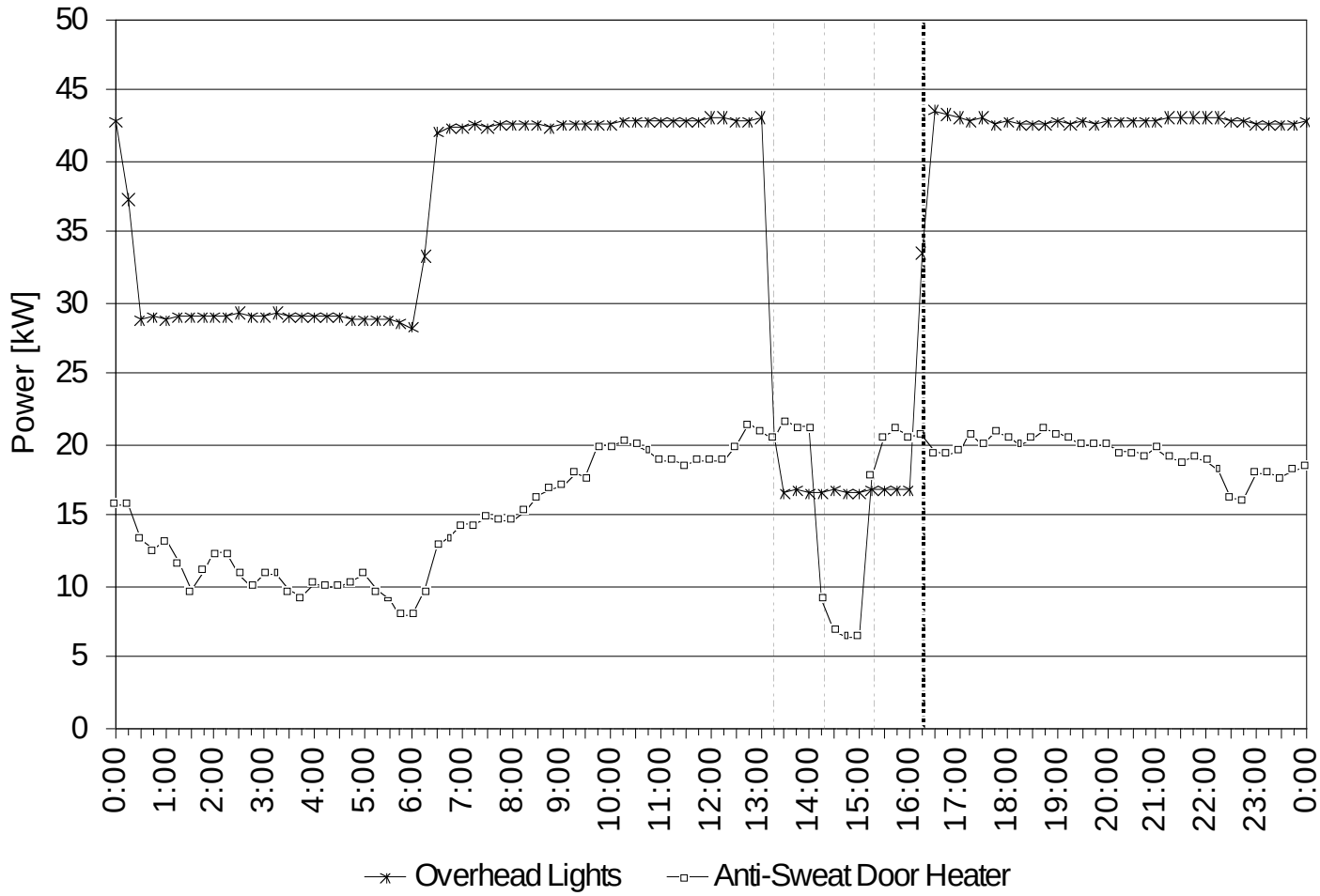
Peng Xu, pxu@lbl.gov

Pre-cooling Research

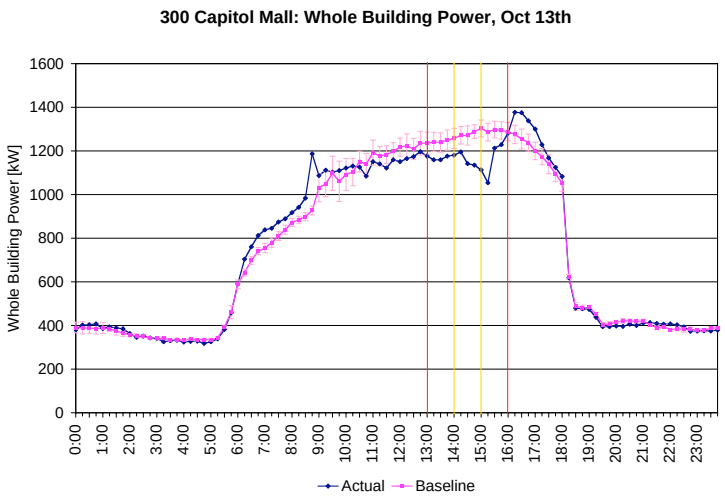
Chuck Goldman, **CAGoldman@lbl.gov**

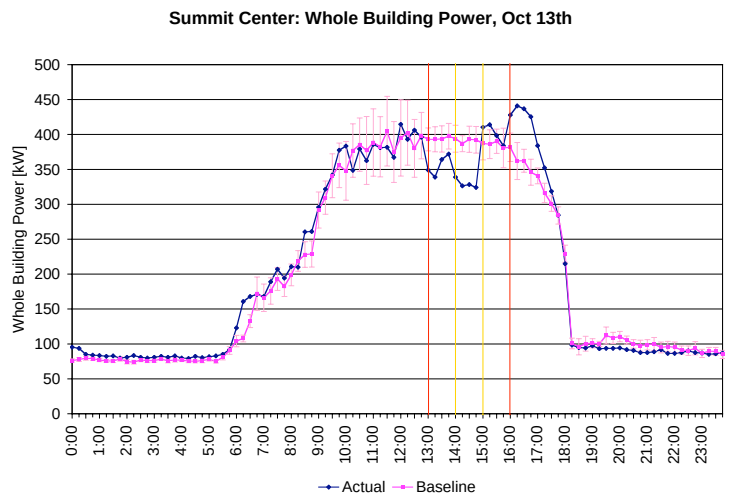
DR Policy Research

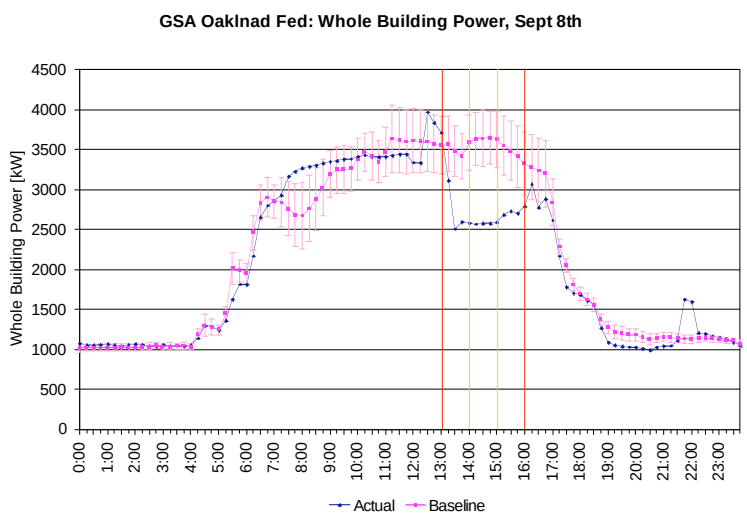
Appendix: Measured Shed Response to Signal (lights and anti-sweat heaters)

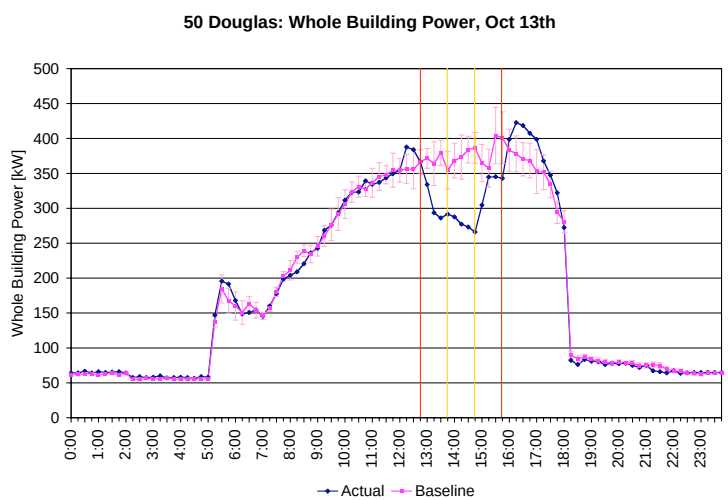


Appendix - Load Shapes from Office Buildings







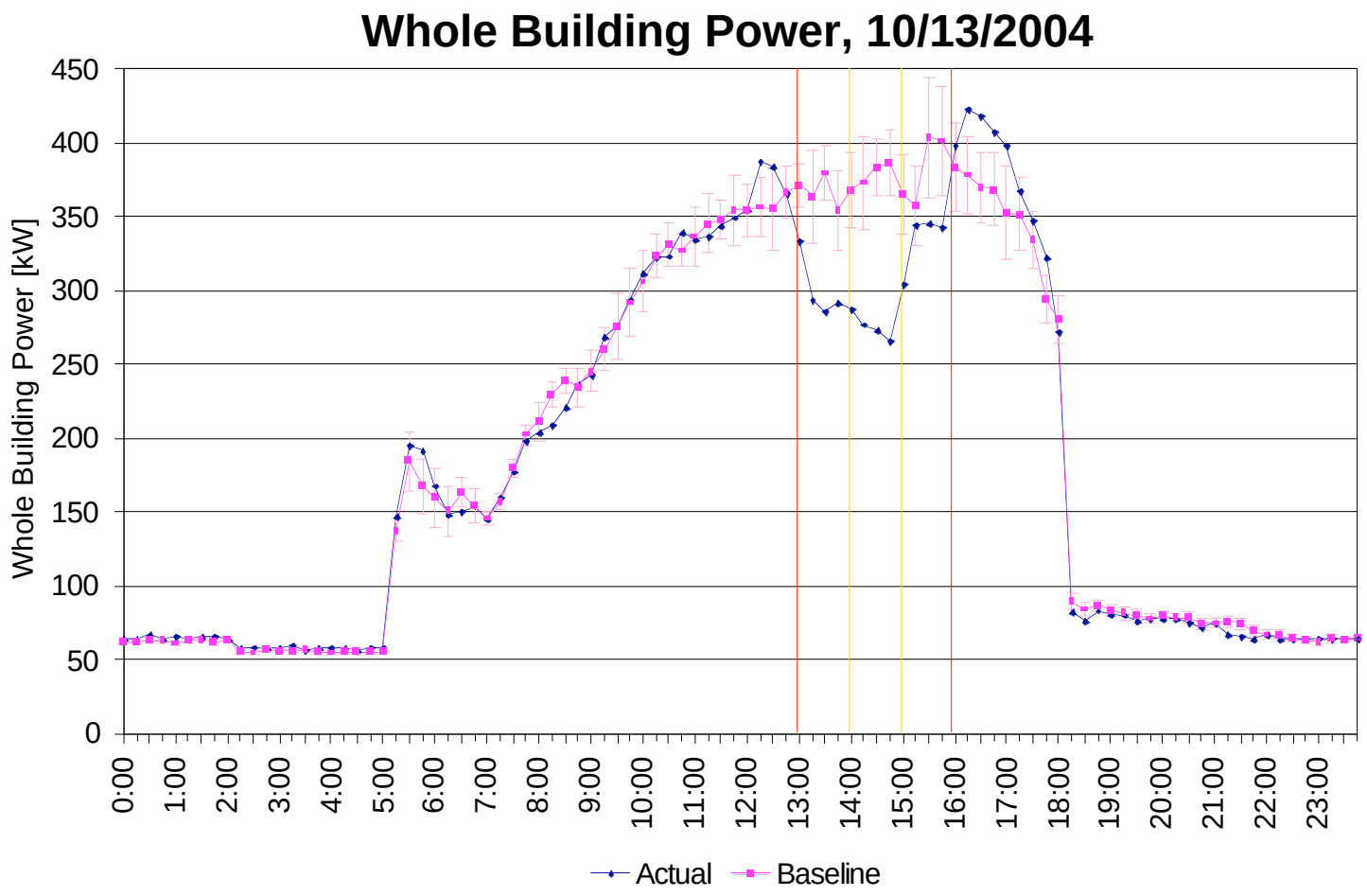
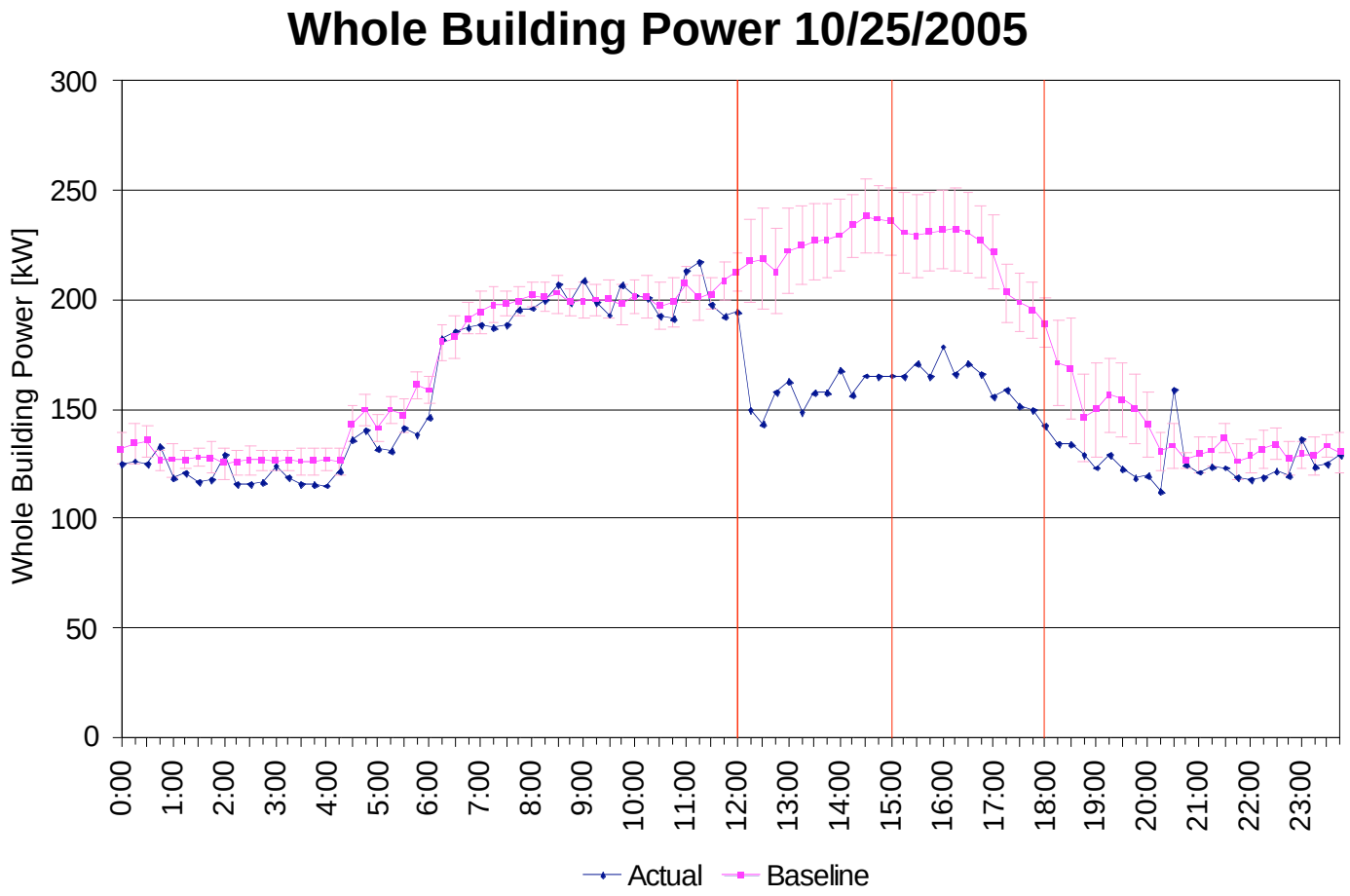


Appendix -

Site Name	Short Name	Location	Building Use	# of Bldg	Floor Space		Peak Load kW (Sept)
					Total	Conditioned	
300 Capitol Mall	**300 CMall**	Sacramento	Office	1	426,000	383,000	1,580
Albertsons, Fruitville	**Albertsons**	Oakland	Supermarket	1	50,000	50,000	450
Bank of America Concord Data Center	**B of A**	Concord	Bank office	3	616,000	708,000	5,380
Joe Serna Jr. Cal/EPA Headquarters Building	**Cal EPA**	Sacramento	Office	1	950,000	950,000	1,990
CANMET Energy Technology Centre - Varennes	**CETC**	Varennes (Quebec, Can)	Research Facility	1	45,000	18,000	240
Cisco Systems	**Cisco**	San Jose Milpitas	Office Tech Lab	24	4,466,000	4,466,000	27,860
Contra Costa County 50 Douglas	**50 Douglas**	Martinez	Office	1	90,000	90,000	500
Contra Costa County Summit Center	**Summit Ctr**	Martinez	Office	1	131,000	131,000	500
Echelon San Jose Headquarter	**Echelon**	San Jose	Office	1	75,000	75,000	410
GSA Phillip Burton San Francisco Federal Building	**450 GG**	San Francisco	Federal Office	1	1,424,000	1,424,000	2,130
GSA National Archives & Records Administration	**NARA**	San Bruno	Archive Storage	1	238,000	202,000	280
GSA Ronald V. Dellums Oakland Federal Building	**OFB**	Oakland	Federal Office	1	1,105,000	978,000	4,100
Kadant Grantek	**Kadant**	Green Bay (WI)	Material Process	1	100,000	0	1,440
Monterey Commerce Center	**Monterey**	Monterey	Commercial	1	170,000*	170,000*	N/A
OSIsoft	**OSIsoft**	San Leandro	Office	1	60,000	60,000	300
Roche Palo Alto	**Roche**	Palo Alto	Cafeteria Auditorium	3	192,000	192,000	750
UC Santa Barbara Davidson Library	**UCSB**	Santa Barbara	Library	1	289,000	289,000	1,090
US Postal Service, San Jose Process & Distribution Center	**USPS**	San Jose	Distribution Center	1	390,000	390,000	1,630
Total				36	10,647,000	10,406,000	50,630

* Monterey is not included in the total, because this site was used only for communication test.

Appendix - Contra Costa, 50 Douglas Martinez, CA



Appendix - Alameda County Water District Fremont, CA