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***Achieving Excellence - the Facilities Management and Sustainability* Workshop**

June 17, 2011

Demand Response

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Demand Response

- The Purpose of Demand Response (DR)
- DR Compensation
- UNM Control System Design
- Sandia National Laboratories DR Pilot

The Purpose of Demand Response

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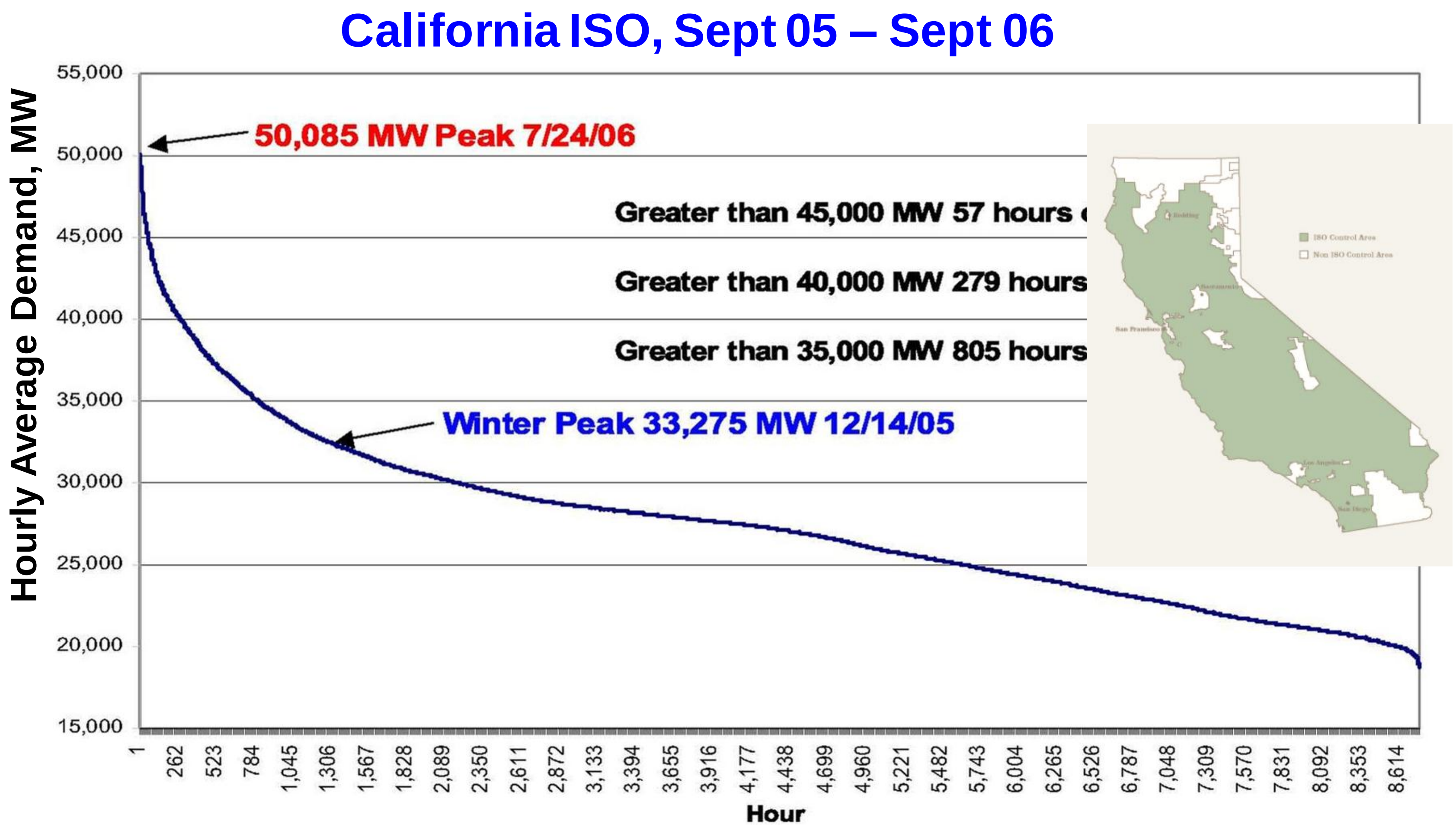

The Purpose of Demand Response

Voluntary action by customers to change their consumption of electric power in response to:

- **Direction**
- **Incentives**
- **Price Signals**

from grid operators at times of **high wholesale market prices** or when electric suppliers **reserve margins are low**.

Typical Time Period:	12:00 noon to 7:00 pm
Typical Frequency:	8 to 15 times per year

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The Purpose of Demand Response

Benefits of Demand Response

- Reduction in wholesale power prices
- More efficient operation of power markets
- Enhances reliability of power system
- Environmental benefits due to reduced generation
- Cost savings from avoided/deferred new generation and T&D

FERC DR Savings Estimates by 2019:

Business as Usual (BAU)	**4%**	**38 GW**
Expanded BAU	**9%**	**82 GW**
Achievable Participation	**14%**	**138 GW**
Full Participation	**20%**	**188 GW**

DR Compensation

Economic Drivers

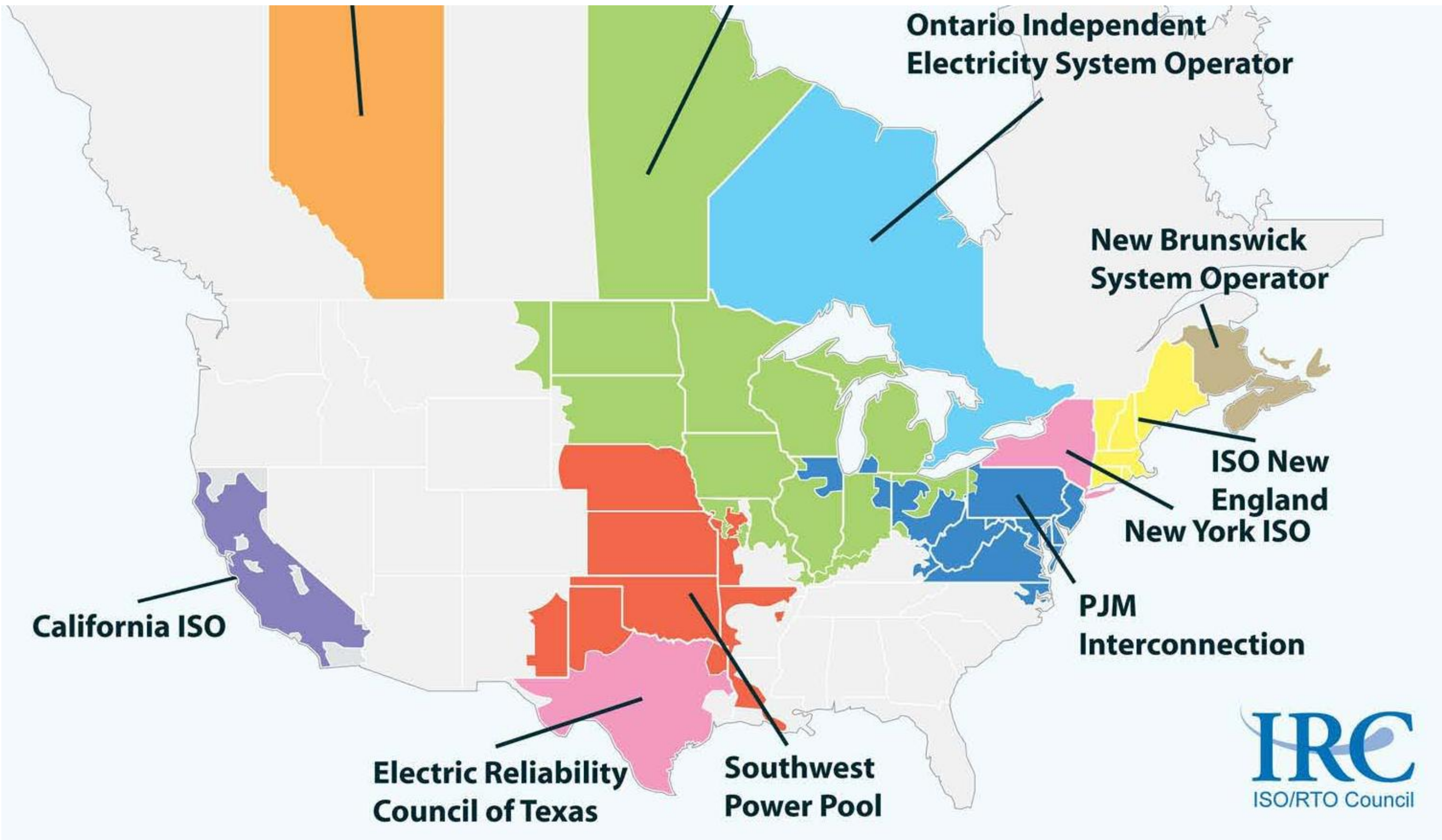
- Fuel Cost Savings (50-70 $/MWh)
- Wholesale Price of Electricity on Peak (1000 – 5000 $/MWh)
- Avoided/Delayed Capital Cost for New Peaking Generation (~1500+ $/MWh)

DR Compensation

FERC Order 745, 3/15/2011 – wholesale market price at time supplied

Alberta Electric System Operator

Midwest ISO



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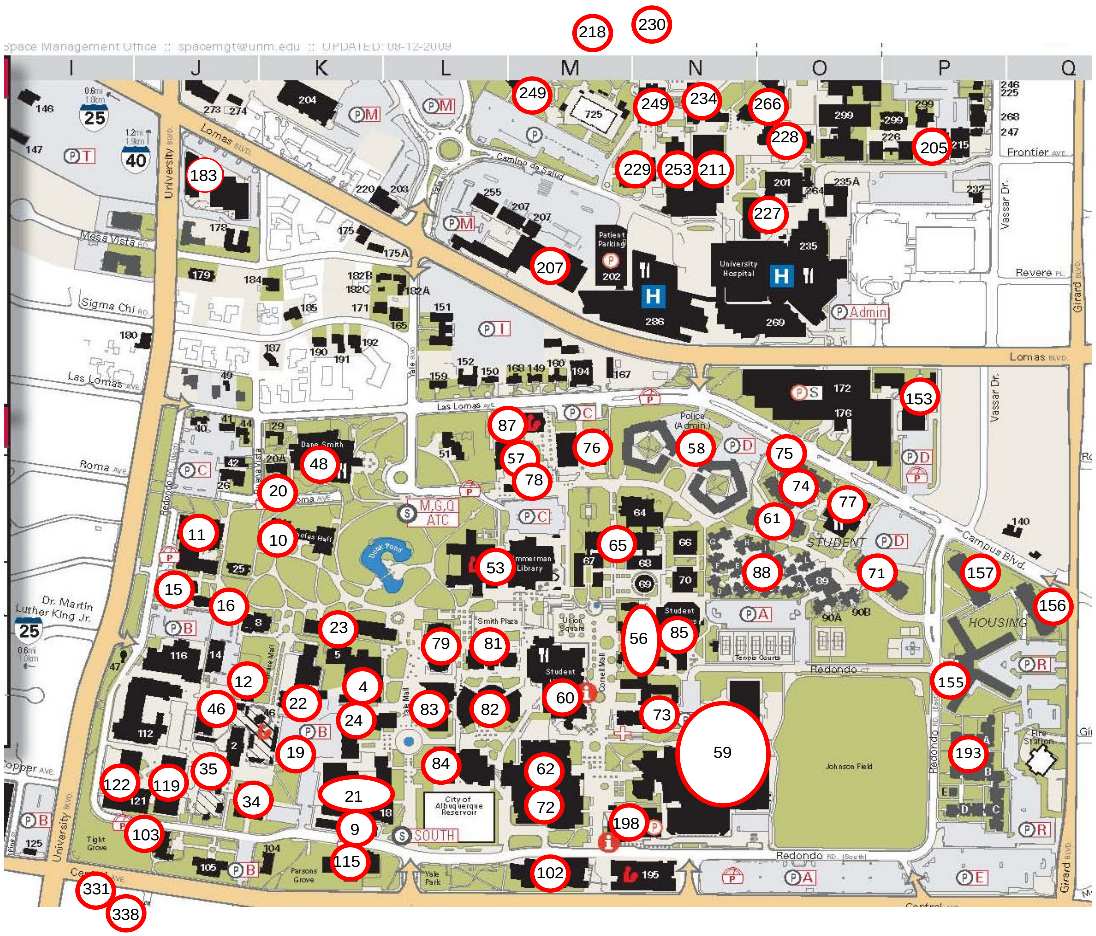
DR Compensation

Independent System Operator (ISO)/ Regional Transmission Org. (RTO)	Price Cap/ $/MWH
California ISO (CAISO)	$1000
Electric Reliability Council of Texas (ERCOT)	$5000
Southwest Power Pool (SPP)	$1000
Midwest ISO (MISO)	$1000
PJM Interconnection (PJM)	$2700
New York ISO (NYISO)	$1000
ISO New England (ISO NE)	$1000

UNM DR Control System Design

- The University of New Mexico (UNM) Campus
- System Design Parameters
- DR Control System
- Results

The University of New Mexico (UNM) Campus



The DR Facilities

- 69 Facilities
- 75% total campus facility area
- Over 90% facility energy use
- Range from 240,000 sq ft to 3,600 sq ft
- Average 71,000 sq ft
- Ave construction date 1964, standard deviation 20 years
- Assume HVAC use VAV with VFD control
- Assume lighting controls through EMCS

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System Design Parameters

UNM Parameters

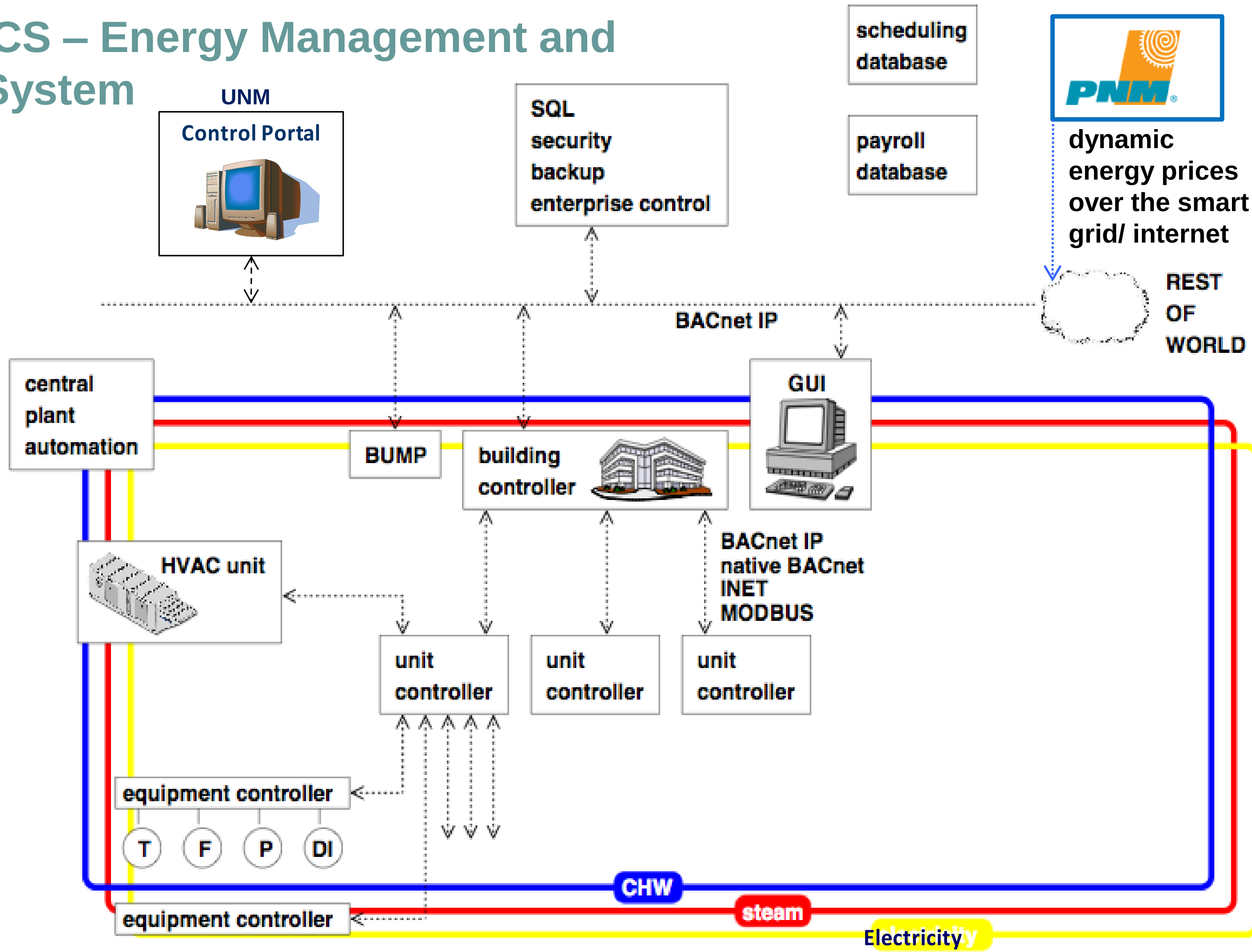
- Raise temperatures in facilities less as occupancy increases

Occupancy		T Set Point
Low	< 20%	80 °F
Med.	20% to 60%	78 °F
High	60% to 90%	76 °F
V. High	> 90%	74 °F

- Participation voluntary (lighting or HVAC)
- Control system will achieve a specific reduction target based on energy price versus percent reduction curve
- For reduction < 100%, facilities chosen randomly

DR Control System

UNM EMCS – Energy Management and Control System

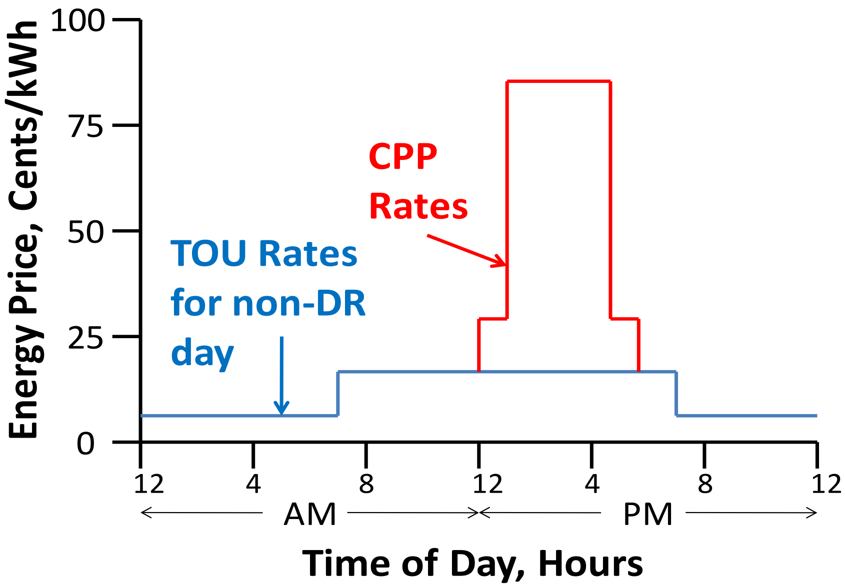


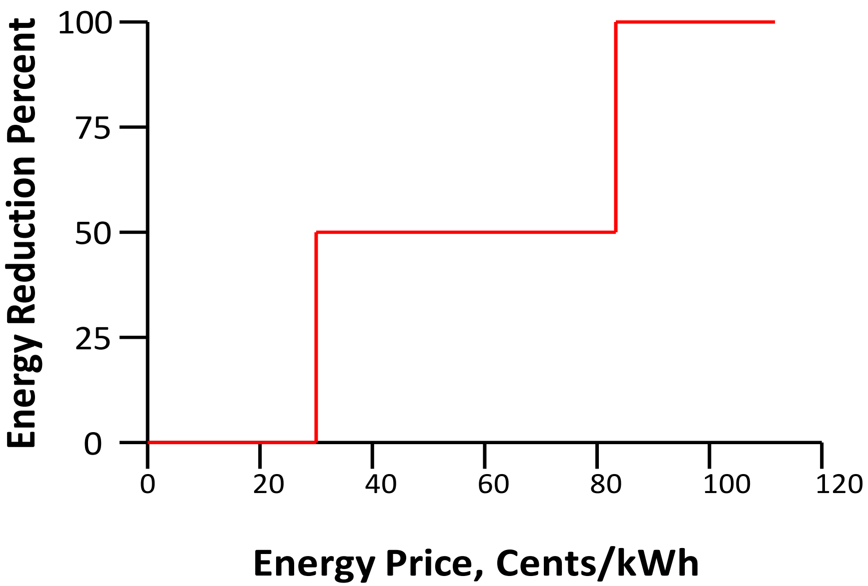
DR Control System

Price Control Strategy

- Power reduction = *f*(energy price)
- Could also be used for conservation on TOU rates

Example

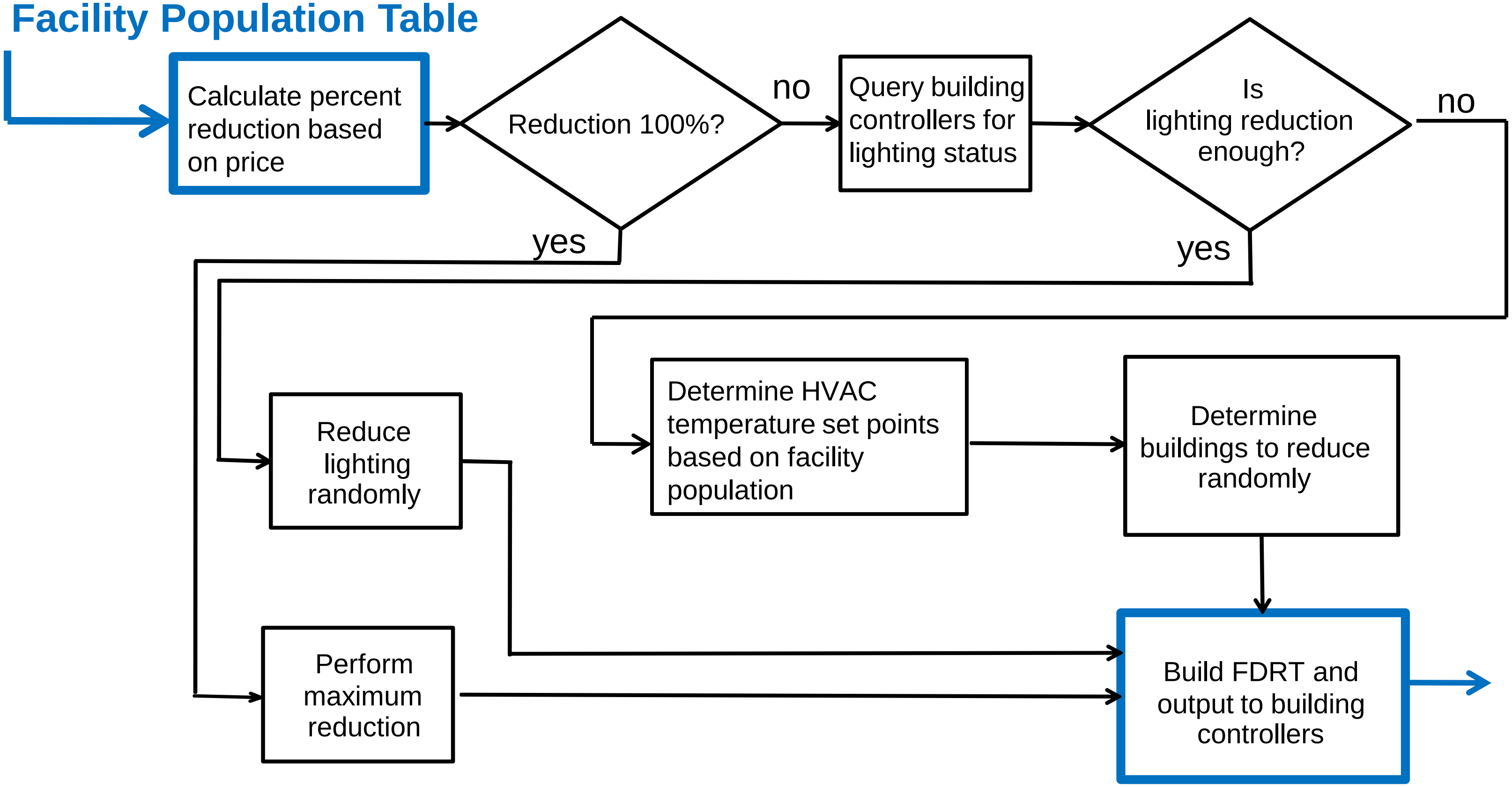




DR Control System

Input:
- Price this hour
- Facility Table
- Facility Population Table

System Flow Chart



Facility DR Table (FDRT)

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DR Control System
Input - Facility Table (FacT)

#	Bldg #	Building	SF	Lights, kW (1.1 w/sf)	Light DR Particip	Temp DR Particip
1	157	Alvarado	40,896	45	0	1
2	76	Anderson School of M	46,406	51	1	1
3	12	Anthropology Annex	9,614	11	1	0

Light kW Reduction Participants	76F kW Reduction Participants	78F kW Reduction Participants	80F kW Reduction Participants
9	13	26	39
10	15	29	44
2	3	6	9

69	331	Crystal Growth Fac	5,110

DR Control Strategy Input - Facility Population Table (Fpop)

Table for Each Day, Monday - Friday

#	Bldg #	Building
1	157	Alvarado
2	76	Anderson School of M
3	12	Anthropology Annex

12:00	1:00	2:00	3:00	4:00	5:00	6:00
L	L	L	L	M	M	H
H	M	H	H	L	L	L
L	L	L	H	S	H	L

69	330	Crystal Growth Fac

DR Control System

Output - Facility Demand Response Table (FDRT)

			Lighting DR						
#	**Bldg #**	**Building**	**12:00**	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**
1	157	Alvarado	0	0	0	0	0	0	0
2	76	Anderson School of M	1	1	1	1	1	1	1
3	12	Anthropology Annex	1	1	1	1	1	1	1

Thermostat Set Point DR						
12:00	**1:00**	**2:00**	**3:00**	**4:00**	**5:00**	**6:00**
74	74	80	80	78	78	74
74	74	74	74	80	80	74
74	74	74	74	74	74	74

69	330	Crystal Growth Fac

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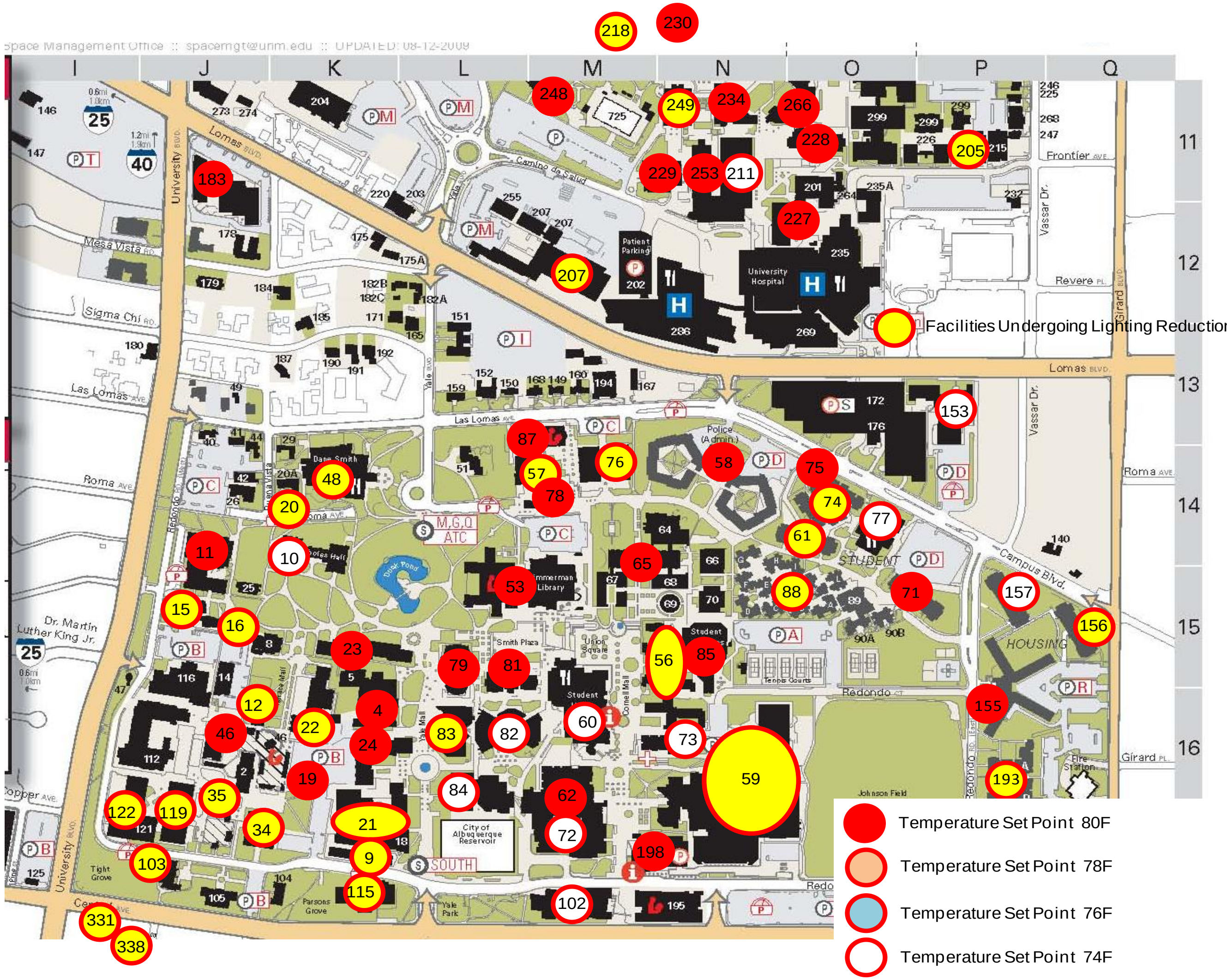
Results

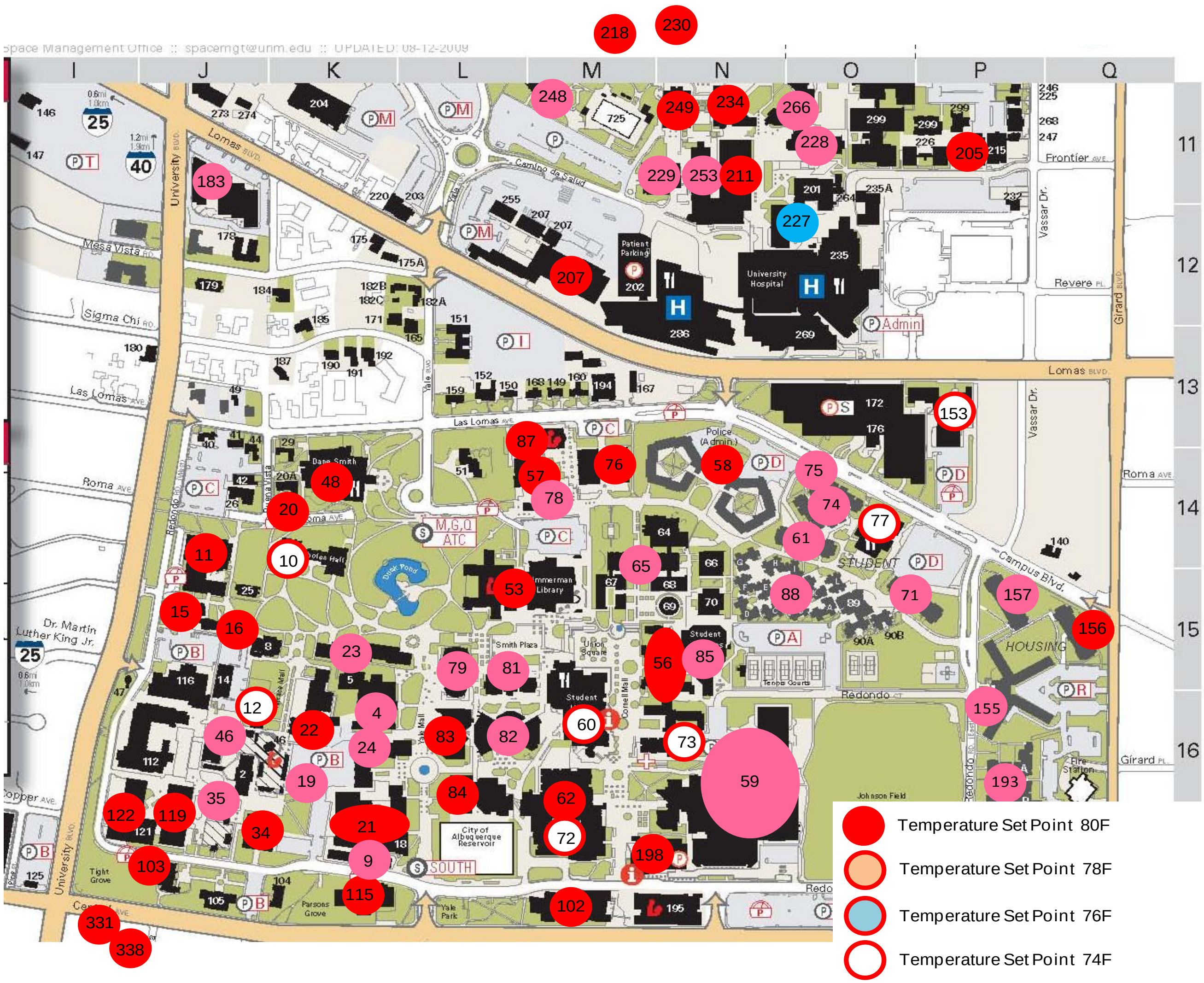
Price 30 cents/kWh, 50% Reduction at 1:00 pm



- Campus Peak 25.0 MW
- DR Reduction 2.6 MW 1.1 MW no light
- 80 deg F - 28
- 78 deg F - 0
- 76 deg F – 0
- Lighting Only 31
- No HVAC Participation 7
- No Lighting Participation 22

Results

Price 86 cents/kWh, 100% Reduction at 4:00 pm



- Campus Peak 25.0 MW
- DR Reduction - 4.2 MW
  3.5 MW no light
- 80 deg F - 32
- 78 deg F - 29
- 76 deg F - 1
- Lighting Only 0
- No HVAC Participation 7
- No Lighting Participation 22

Summary

The DR Control System

- Manages DR event for 69 UNM facilities.
- Designed to reduce power based on energy price.
- Could potentially reduce UNM power by 3000 to 4,500 kW.

Additional Exploratory Work

- Improve the DR reduction estimates for each facility based on actual reduction each hour.

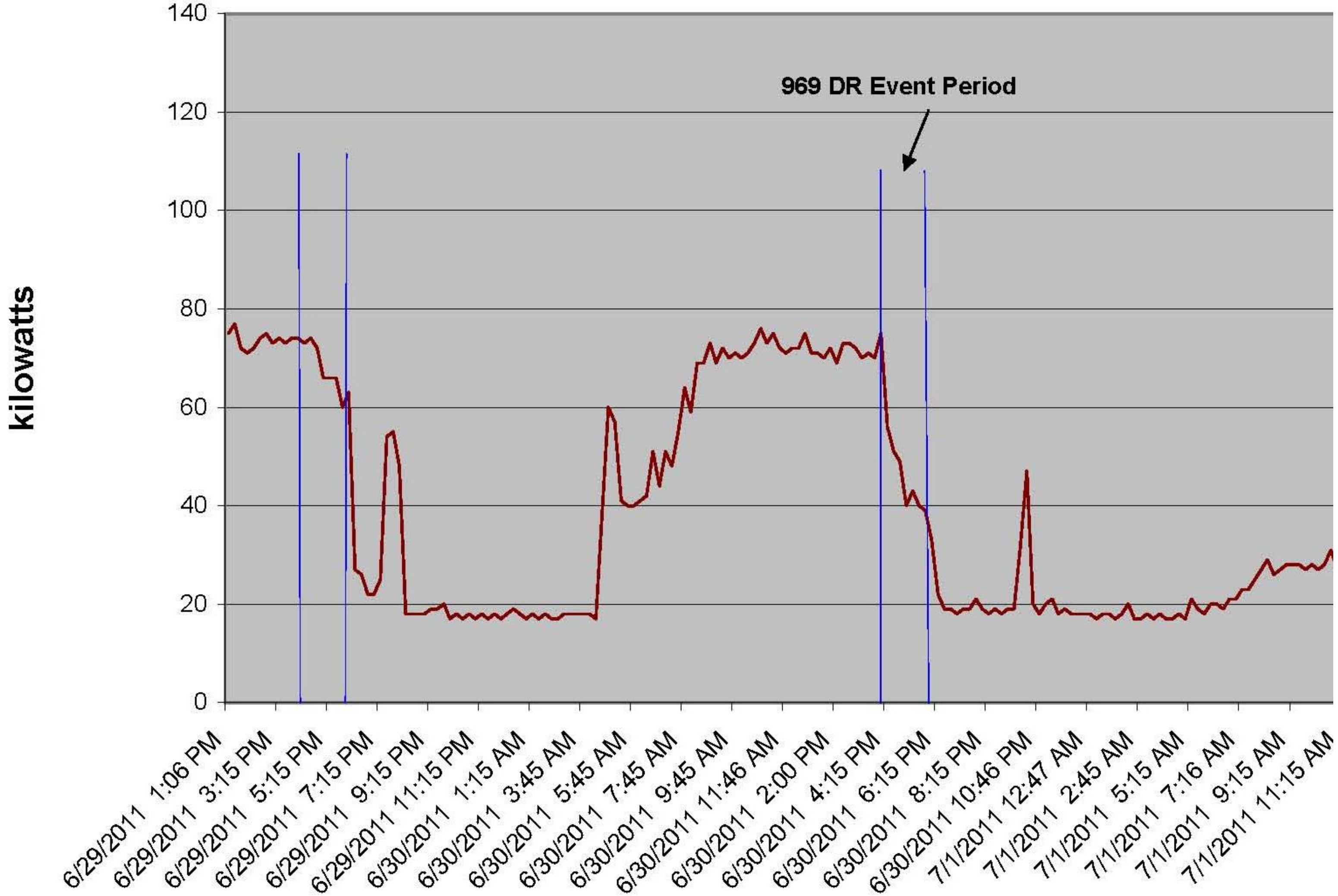
Demand Response Pilot at SNL - Summer 2011

SNL Pilot

DR Pilot Plan SNL Summer 2011

- 41 facilities (1.88M square feet) to include in the DR event,
- Participation of the Air Force,
- The automatic control strategy,
- The specific targets for electric use reduction (HVAC, Cold Water Storage, Computing),
- No control system modifications or upgrades,
- The estimated cost to perform the DR event pilot low,
- The strategy to communicate the DR event to customers

DR Pilot Test – Building 969



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SNL Pilot

Sandia National Laboratories - Assumptions:

- SNL Peak Electric Use – 45.3 MW
- 12 DR Events per year at 6 hours duration each
- 5% to 10% from HVAC DR (2.27 MW to 4.53 MW)
- Computing & Network Services (C&NS) – 6 MW with 33% reduction
- DR valued at wholesale market price cap per MWH ($1000, $2500, $5000)

Compensation Range per Year

$/MWH Price Cap	$1000	$2500	$5000
5% from HVAC DR, 33% C&NS	**$300K**	**$770K**	**$1,500K**
10% HVAC DR, 33% C&NS	**$500K**	**$1,200K**	**$2,400K**

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Discussion

Backup Slides

Implementation

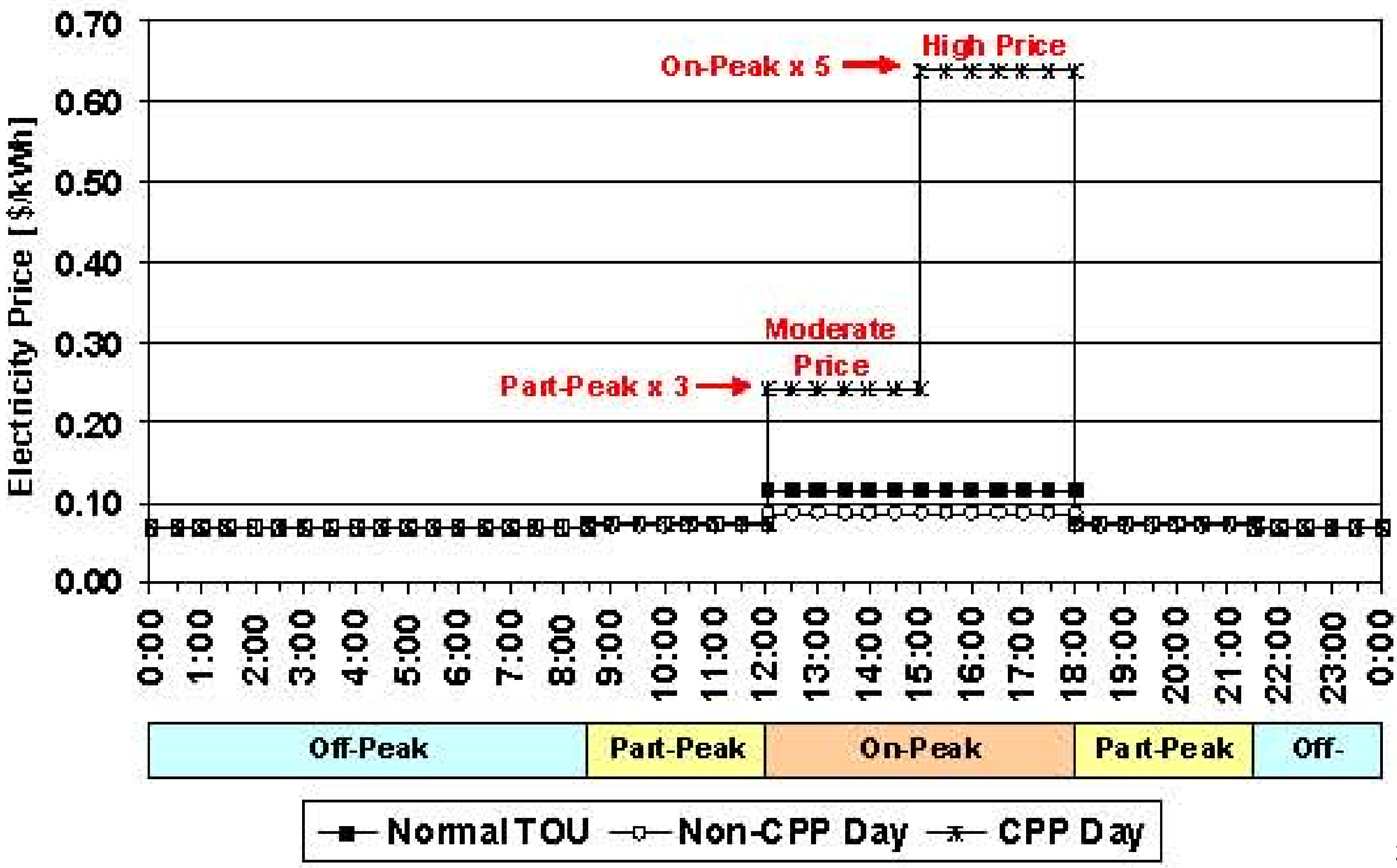
Dynamic Versus Static Pricing

Example Time-of-Use Rates

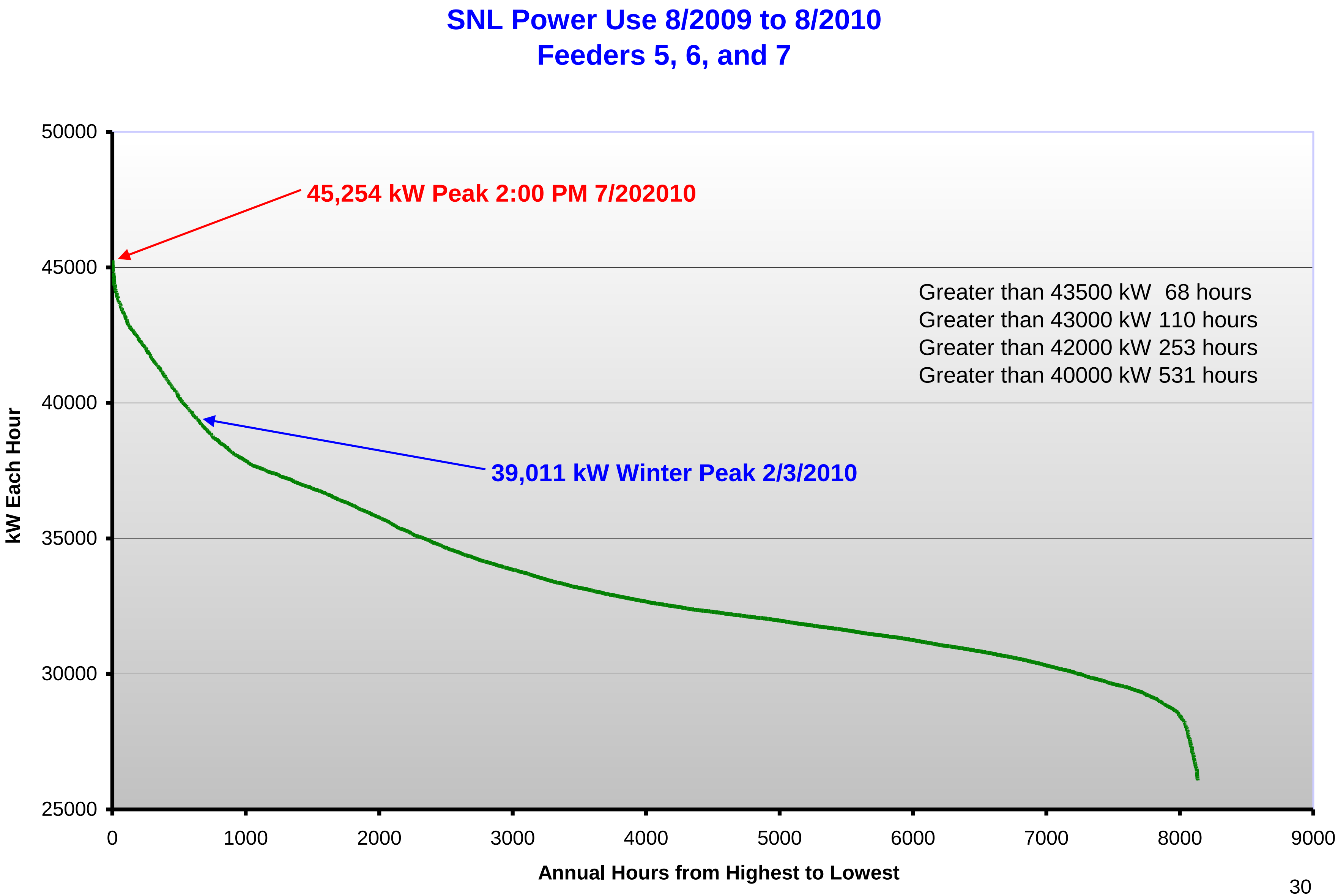
	Off Peak cents/kWh	Near Peak cents/kWh	On Peak cents/kWh
Madison Gas & Electric	3		29
Salt River Project	6.7		21.3
Arizona Public Service	5		24
San Diego Gas & Electric	7		38
Progress Energy	5.4		17.1
Ontario Hydro	5	8	10
Reliant Power	12.1	15.5	17.5
Baltimore Gas and Electric	9.9	11.5	14.9

Implementation

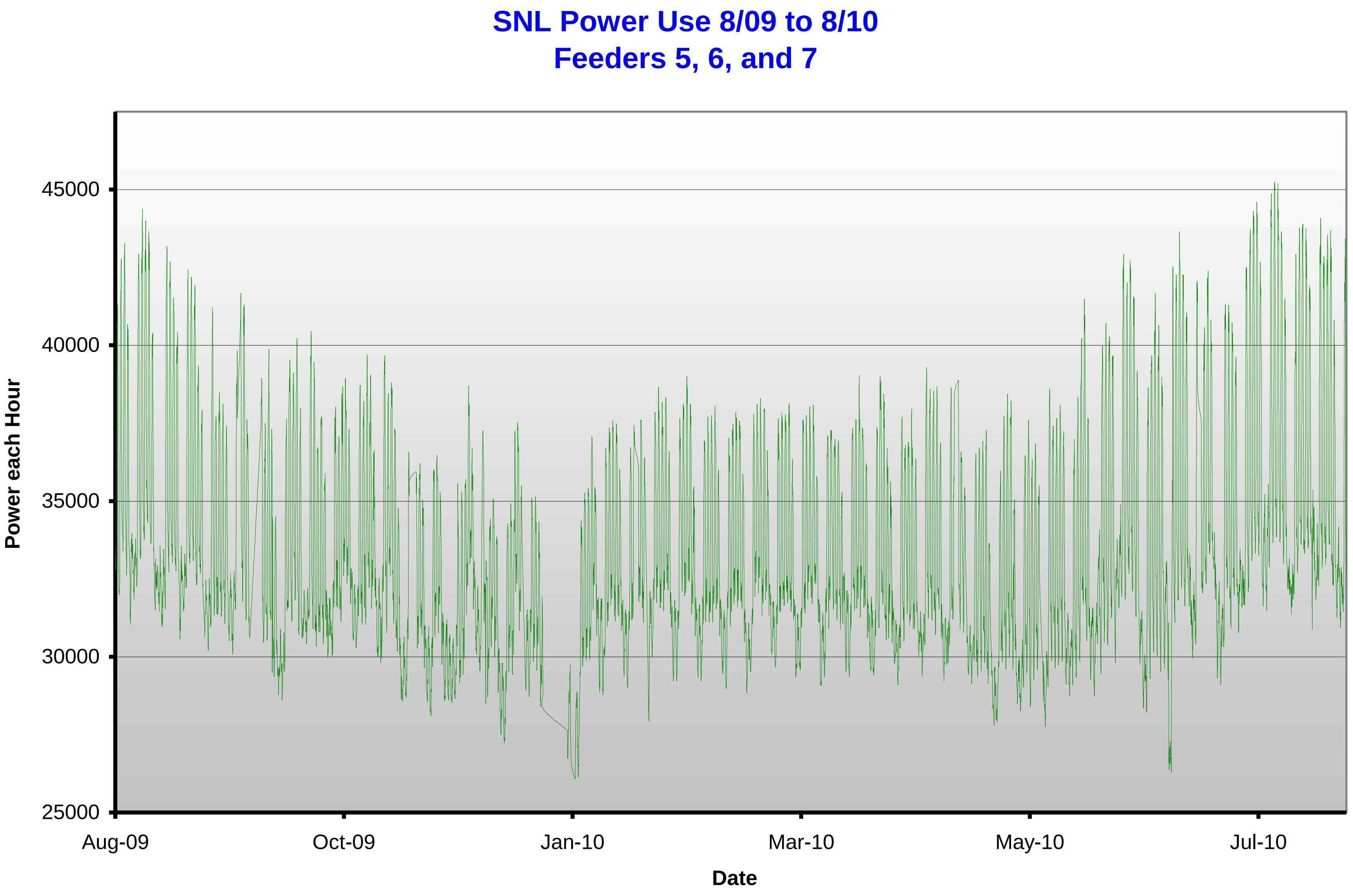
Critical Peak Pricing - California



SNL FY 2010


SNL Power Use 8/2009 to 8/2010
Feeders 5, 6, and 7
45,254 kW Peak 2:00 PM 7/202010
39,011 kW Winter Peak 2/3/2010
Greater than 43500 kW 68 hours
Greater than 43000 kW 110 hours
Greater than 42000 kW 253 hours
Greater than 40000 kW 531 hours
kW Each Hour
50000
45000
40000
35000
30000
25000
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Annual Hours from Highest to Lowest

SNL FY 2010



SNL Power Use 8/09 to 8/10
Feeders 5, 6, and 7
Power each Hour
45000
40000
35000
30000
25000
Aug-09
Oct-09
Jan-10
Mar-10
May-10
Jul-10
Date

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Implementation Issues

	Commercial	Residential
Manual	Facility operator takes specific action	Customer raises thermostat and turns off appliances
Auto	Automated control system responds	AMI with smart thermostat and smart appliances