Price Responsive Loads

BNL’s Smart Grid Workshop, Including REV, NY Prize and Microgirds
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Outline

Overview of dynamic rates

Automated price response in New York

- Goals
- Methods
- Results and Lessons Learned

Current Rates

Dynamic rates have been around for commercial and industrial consumers.

Flat rates are ubiquitous globally for residential customers

- Lack of interval metering
- Concern over customers (won’t understand either time-variant prices or demand charges)

This is changing…

Potential benefits of dynamic rates

- Defer generation investments
- Delay upgrades
- Improve asset utilization
- Reduce congestion costs and T&D losses
- Provide ancillary services

Concerns over dynamic prices

- Customers perceive dynamic pricing to be risky
- Customers won’t respond
- Customers’ response will not vary with varying price
- Enabling technologies won’t boost response
- Customers’ response won’t persist

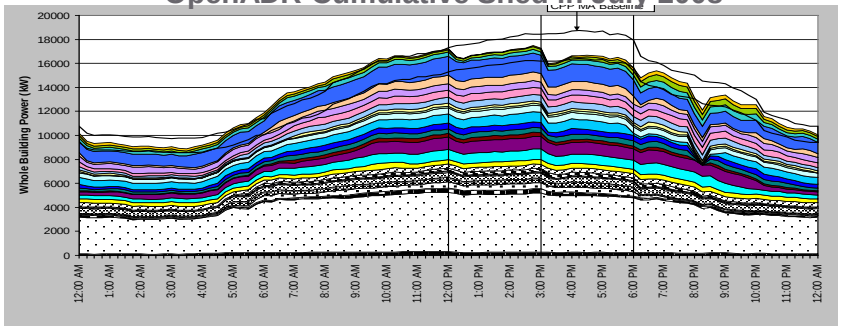
Dynamic pricing is being practiced widely in the US

- Arizona
- Illinois
- Massachusetts
- Mid-Atlantic Region
- Oklahoma
- California
- New York

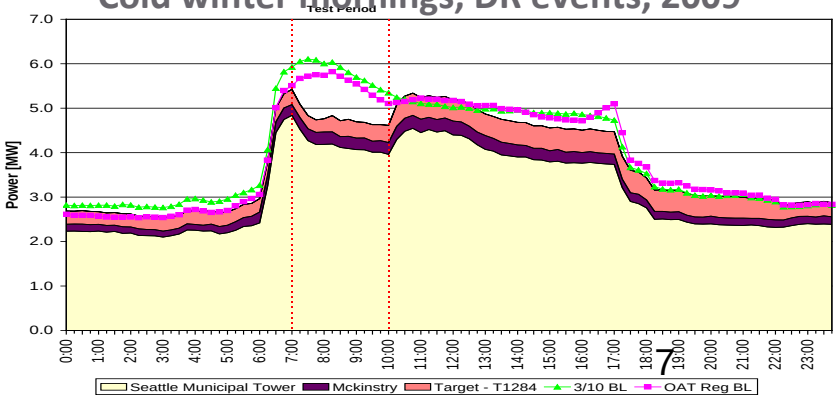
demonstrations

Hot summer afternoons day-ahead price response

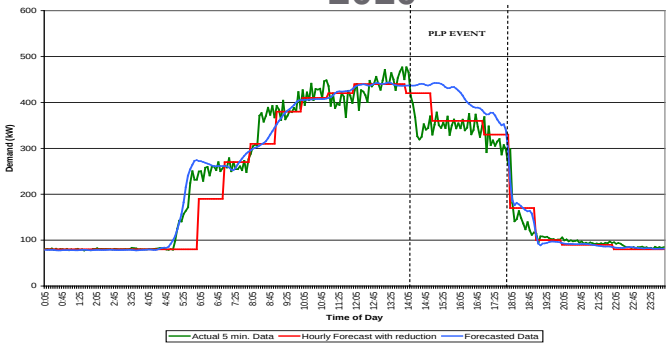
OpenADR Cumulative Shed in July 2008



Cold winter mornings, DR events, 2009



DR and Ancillary Services non-spinning reserve demonstration, 2010



Automated Price Response in NY

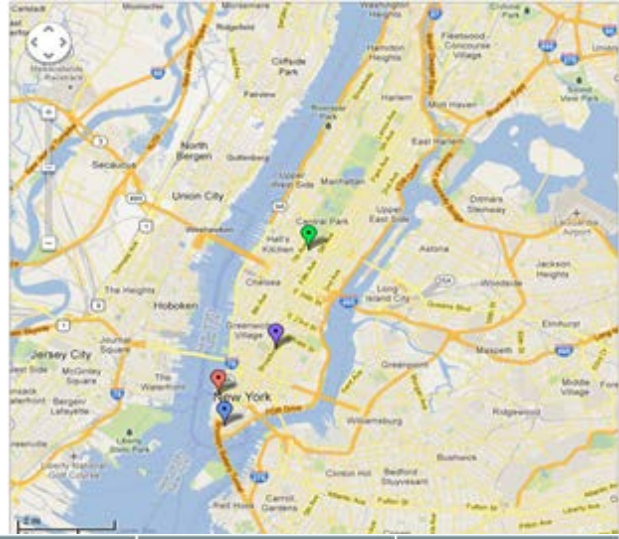
Objective:

Demonstrate Automate Demand Response (DR) in large commercial buildings under dynamic pricing in New York City using OpenADR communication protocol.

Tasks:

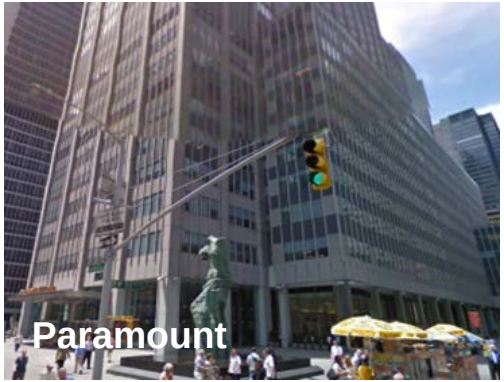
- Provide ADR communication and technical solutions to large customers
- Provide cost-saving solutions to manage day-ahead hourly prices and demand charges
- Demonstrate how the adoption of OpenADR can provide greater flexibility and controllability of demand-side resources to various stakeholders in NYS

Summary of Sites



Customer Name	Business Type	Peak Load (kW)	Peak Load Intensity (W/m^2)	Load Factor	Annual Consumption (kWh)	Electricity Supplier	Demand Response Programs	Curtailment Service Provider
MTA	Office	6,192	47.6	0.51	27,611,976	NYPA	NYISO SCR & EDRP	Energy Curtailment Specialist
Paramount	Office	3,940	24.8		8,716,800	Direct Energy	NYISO SCR & EDRP ConEd DLRP & CSRP	iES
WFC – Tower A	Office	4,640	35.7		24,782,400	NYPA	NYISO SCR Con Ed DLRP	Constellation

Summary of Sites cont.



MTA - Predictable, good DR participation, Night flush on weekends and pre-cooling in the summer.

- DR strategy: Global temperature adjustment
- Honeywell systems (EBI)
- BACnet

NYU - classes, students. No DR participation before.

- DR strategy: Global temperature adjustment and lighting
- Automated Logic
- BACnet

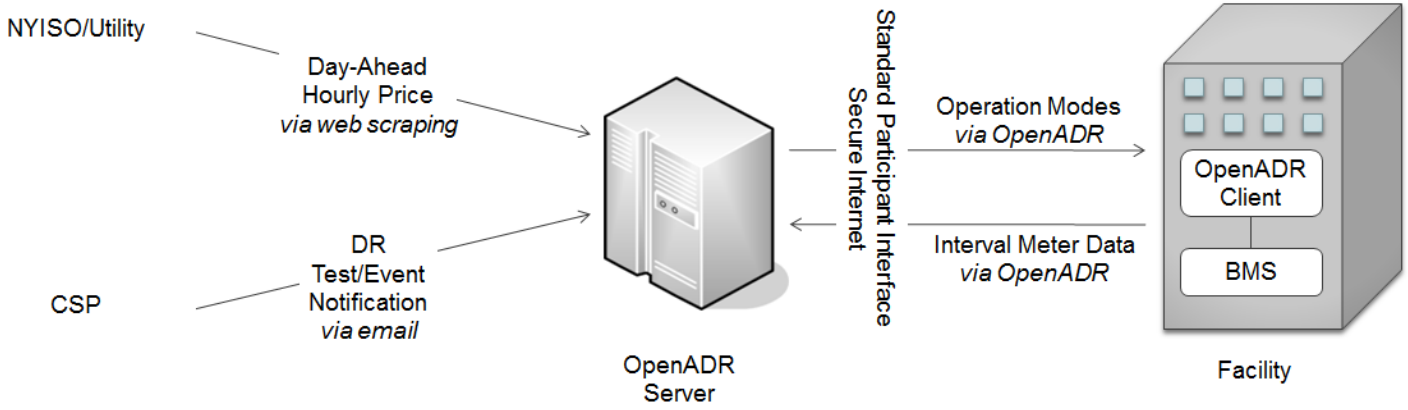
Paramount - Onsite generation and low loads

- DR strategy: Global temperature adjustment
- Schneider's Andover Continuum
- BACnet

WFC - Building vs. Central plant

- DR strategy: Global temperature adjustment
- JCI Metasys
- Proprietary control protocol

Communication and Controls

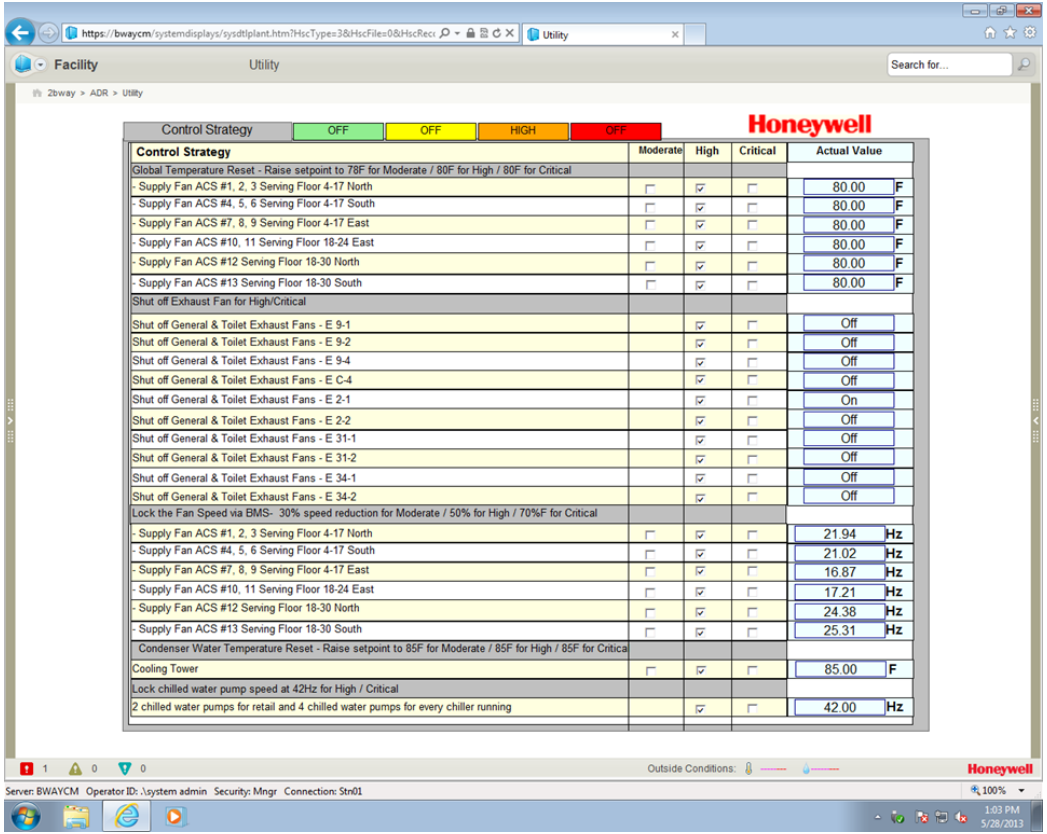


Day	Signal Type	Operation Mode
DR Test/Event	Reliability	Critical
	Demand Limiting	High
Non DR Test/Event	Day-Ahead Hourly Prices	High, Moderate

DR Strategies

Facility	Operation Mode	Global temperature adjustment	Passive thermal mass storage	Supply fan speed reduction	Exhaust fan quantity reduction	Chilled water temperature increase	Chilled water pump speed reduction	Shutting off chilled water pumps	Chiller quantity reduction	Condenser water temperature increase	Shutting off condenser water pumps	Slow recovery	Sequential equipment recovery	Extended DR control Period	Turning off lighting in auxiliary space
MTA	Critical	x	x	x	x	x	x	x	x	x	x	x	x	x	P*
	High	x	x	x	x	x	x			x	x	x	x	x	
	Moderate	x		x		x				x	x	x	x	x	
Paramount	Critical			x	x		x			x		x	x	x	
	High			x	x		x			x		x	x	x	
	Moderate			x			x			x		x	x	x	
WFC – Tower A	Critical			x	x			x				x	x	x	
	High			x	x			x				x	x	X	
	Moderate				x			x				x	x	x	
NYU - Fairchild	Critical	x	x	x	x						x	x	x	x	P*
	High	x	x	x	x						x	x	x	x	P*
	Moderate	x		x							x	x	x	x	P*

User interface



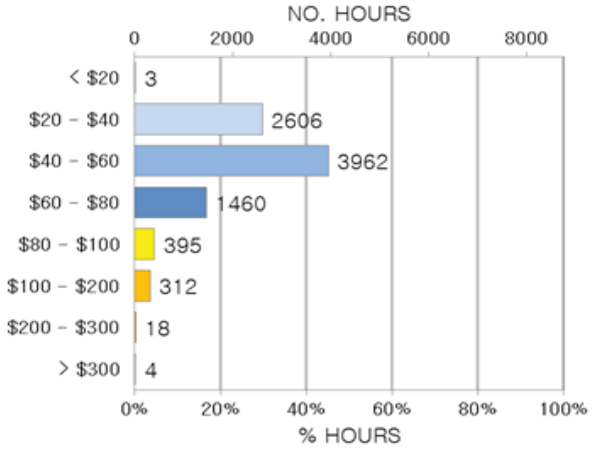
Control Strategy	OFF	OFF	HIGH	OFF

Control Strategy	Moderate	High	Critical	Actual Value	
Global Temperature Reset - Raise setpoint to 78F for Moderate / 80F for High / 80F for Critical					
- Supply Fan ACS #1, 2, 3 Serving Floor 4-17 North	☐	☑	☐	80.00	F
- Supply Fan ACS #4, 5, 6 Serving Floor 4-17 South	☐	☑	☐	80.00	F
- Supply Fan ACS #7, 8, 9 Serving Floor 4-17 East	☐	☑	☐	80.00	F
- Supply Fan ACS #10, 11 Serving Floor 18-24 East	☐	☑	☐	80.00	F
- Supply Fan ACS #12 Serving Floor 18-30 North	☐	☑	☐	80.00	F
- Supply Fan ACS #13 Serving Floor 18-30 South	☐	☑	☐	80.00	F
Shut off Exhaust Fan for High/Critical					
Shut off General & Toilet Exhaust Fans - E 9-1		☑	☐	Off	
Shut off General & Toilet Exhaust Fans - E 9-2		☑	☐	Off	
Shut off General & Toilet Exhaust Fans - E 9-4		☑	☐	Off	
Shut off General & Toilet Exhaust Fans - E C-4		☑	☐	Off	
Shut off General & Toilet Exhaust Fans - E 2-1		☑	☐	On	
Shut off General & Toilet Exhaust Fans - E 2-2		☑	☐	Off	
Shut off General & Toilet Exhaust Fans - E 31-1		☑	☐	Off	
Shut off General & Toilet Exhaust Fans - E 31-2		☑	☐	Off	
Shut off General & Toilet Exhaust Fans - E 34-1		☑	☐	Off	
Shut off General & Toilet Exhaust Fans - E 34-2		☑	☐	Off	
Lock the Fan Speed via BMS- 30% speed reduction for Moderate / 50% for High / 70%F for Critical					
- Supply Fan ACS #1, 2, 3 Serving Floor 4-17 North	☐	☑	☐	21.94	Hz
- Supply Fan ACS #4, 5, 6 Serving Floor 4-17 South	☐	☑	☐	21.02	Hz
- Supply Fan ACS #7, 8, 9 Serving Floor 4-17 East	☐	☑	☐	16.87	Hz
- Supply Fan ACS #10, 11 Serving Floor 18-24 East	☐	☑	☐	17.21	Hz
- Supply Fan ACS #12 Serving Floor 18-30 North	☐	☑	☐	24.38	Hz
- Supply Fan ACS #13 Serving Floor 18-30 South	☐	☑	☐	25.31	Hz
Condenser Water Temperature Reset - Raise setpoint to 85F for Moderate / 85F for High / 85F for Critica					
Cooling Tower	☐	☑	☐	85.00	F
Lock chilled water pump speed at 42Hz for High / Critical					
2 chilled water pumps for retail and 4 chilled water pumps for every chiller running		☑	☐	42.00	Hz

Methodology

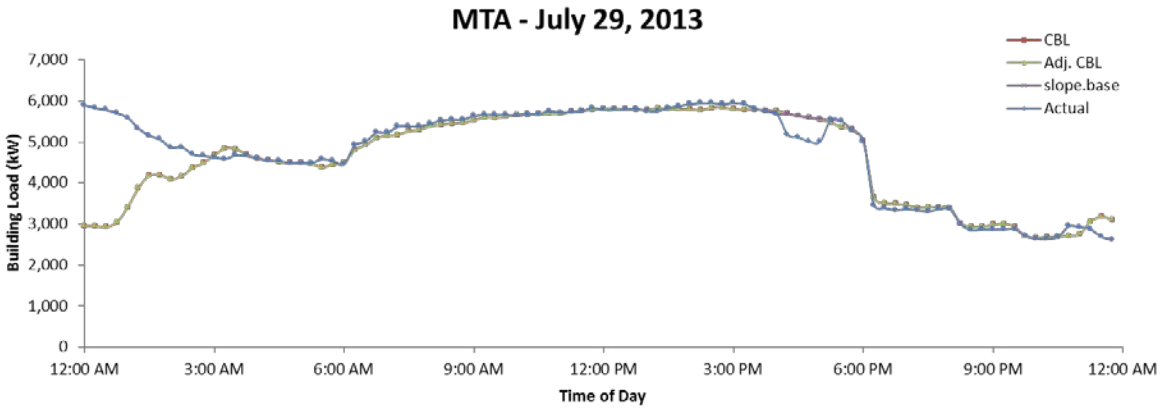
- Physical modeling of loads and sheds- MTA only
- Statistical modeling of loads
- DR test events to quantify sheds (moderate, high only)
- Using the models and cost minimization targets to come up with acceptable operational strategies and constraints.
  - Energy costs focusing on cost duration (cost x demand)
  - Demand charges focusing on reducing monthly peak targeting monthly load duration

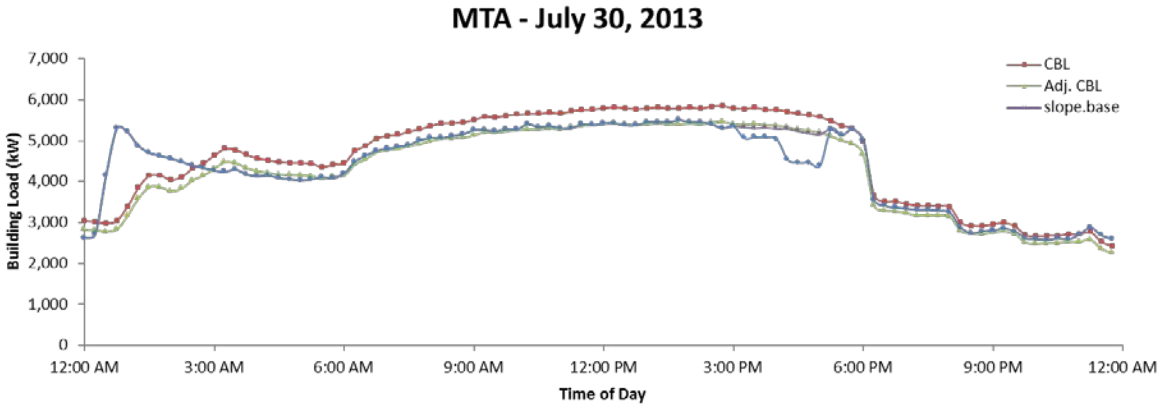
MTA cost management opportunities



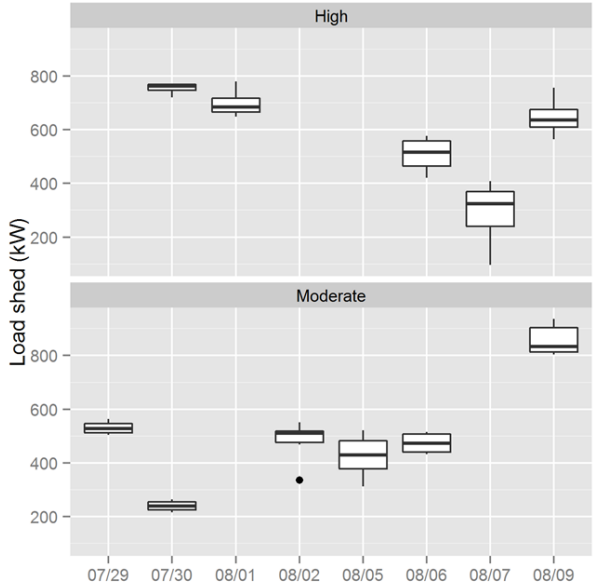
Up to 20 tests on non-DR event days 1 to 3 hour in duration focusing on medium and high shed events during hottest days of the week.

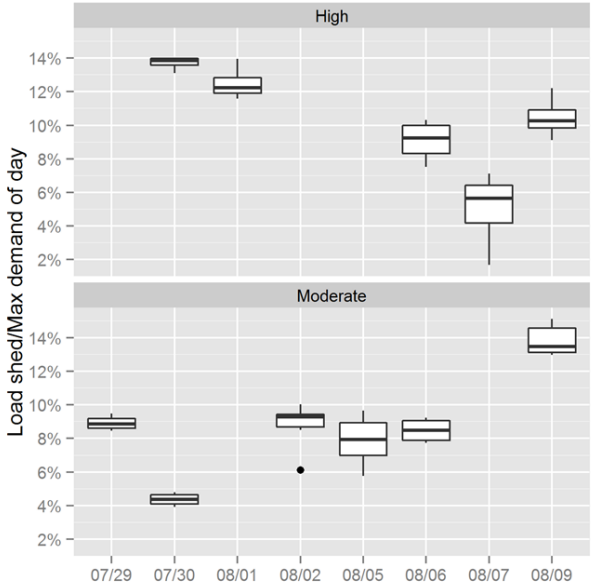
Sample results from test events





Quantifying MTA's moderate and high modes





Target demand is set based on simulations and monthly load duration

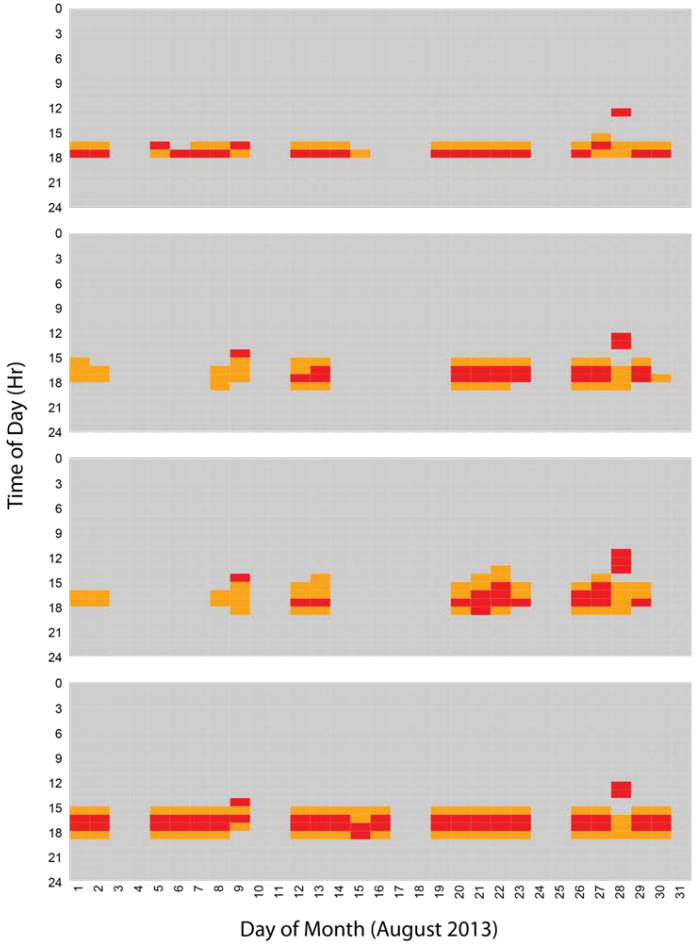
	Moderate	High
Avg. Load Shed (kW)	480	652

Daily and Monthly Limits Scenarios

ID	Description	Daily Limit (hr)		Monthly Limit (hr)	
		Moderate	High	Moderate	High
Case 0:	No price response	0	0	0	0
Case 1:	Price response w/ month limits - low impact	2	1	40	20
Case 2:	Price response w/ month limits - med impact	3	2	40	20
Case 3:	Price response w/ month limits - high impact	4	3	40	20
Case 4:	Price response w/o month limits - med impact	3	2	unlimited	unlimited

Reduced Level of Service
& Occupant Comfort

Price Response Schedule (Simulated)



Case 1: PR w/ Monthly Limits - Low Impact

Normal	: 684 hrs/month
Moderate	: 40 hrs/month
High	: 20 hrs/month
Max. Savings	: $5,910 for Aug 2013

Case 2: PR w/ Monthly Limits - Med Impact

Normal	: 684 hrs/month
Moderate	: 40 hrs/month
High	: 20 hrs/month
Max. Savings	: $8,220 for Aug 2013

Case 3: PR w/ Monthly Limits - High Impact

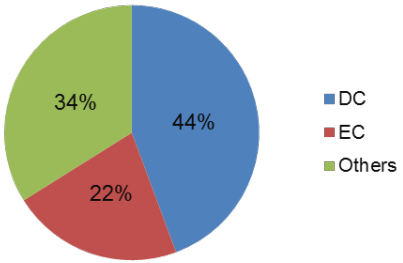
Normal	: 684 hrs/month
Moderate	: 40 hrs/month
High	: 20 hrs/month
Max. Savings	: $8,770 for Aug 2013

Case 4: PR w/o Monthly Limits - Med Impact

Normal	: 634 hrs/month
Moderate	: 66 hrs/month
High	: 44 hrs/month
Max. Savings	: $10,900 for Aug 2013

Impact on utility bill

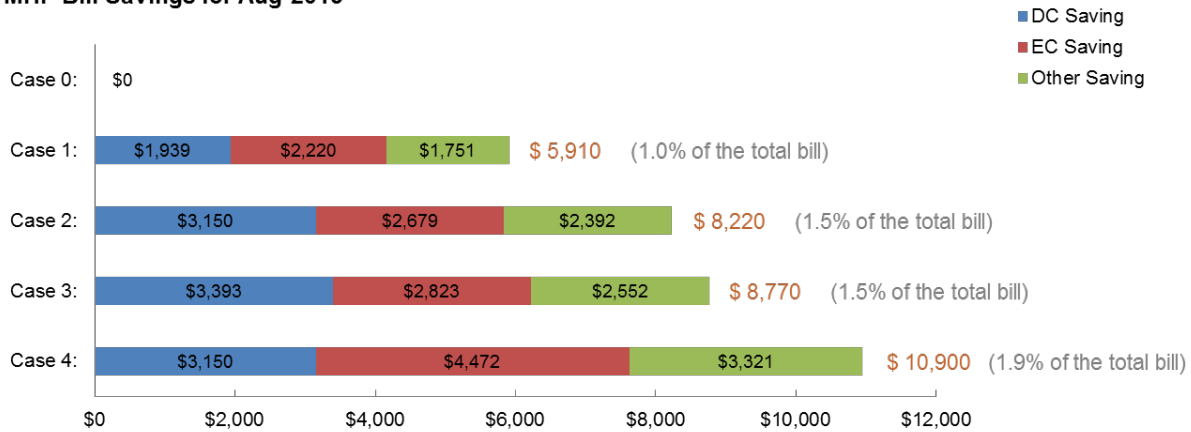
MHP Bill for Aug 2013



Total Estimated MHP Bill: $ 566,600

(not including taxes)

MHP Bill Savings for Aug 2013



Lessons Learned

Cost: ~ 20k/site in NY, 3-5k/site in CA

- Knowledge of systems lacking
- Incorporating Auto-DR in Codes and Standards can reduce costs (Title 24, LEED)

Facility engineers liked

- understanding flexibility of the resources and monetary benefits
- having the freedom to opt-out
- automated control over their system (NOT utility control)

Thank you!

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Papers and reports related to OpenADR and NY project can be found at http://drrc.lbl.gov