



# Carrots for Smart Grid Tricks!

SmartGrid.gov

Recovery Act:  
Consumer Behavior Studies

The Consumer Behavior Studies presented an opportunity to advance the electricity industry's understanding of consumer behavior through the application of statistically rigorous experimental methods.

[Learn more about DOE's approach to the Consumer Behavior Studies >>](#)

SGIG recipients undertaking consumer behavior studies were obligated to develop consumer behavior study plans that meet DOE standards in the Guidance Documents for the Consumer Behavior Studies. In addition, each recipient was responsible for conducting their own evaluations and submitting reports that summarized results. DOE also conducted cross-study analysis to evaluate impacts on peak demand, total electricity use and consumer acceptance and retention.

Participating Utilities (Click on company name to see reports)	Study Description	Evaluation Reports	
		Interim	Final
<a href="#">Central Vermont Public Service to "Green Mountain Power" -eEnergy Vermont</a>	<a href="#">Download</a>	<a href="#">Download</a>	
<a href="#">Detroit Edison - SmartCurrents Home Project</a>	<a href="#">Download</a>	<a href="#">Download</a>	
<a href="#">FirstEnergy - Smart Grid Modernization Initiative</a>	<a href="#">Download</a>	<a href="#">Download</a>	
<a href="#">Lakeland Electric - Smart Metering Infrastructure Initiative</a>	<a href="#">Download</a>		
<a href="#">Marblehead Municipal Light Department - Residential Dynamic Pricing Pilot Project</a>	<a href="#">Download</a>		
<a href="#">Minnesota Power - AMI Behavioral Research</a>	<a href="#">Download</a>		-

Smart Grid Investment Grant Program

Overview

Consumer Behavior Studies

Program Impacts +

Deployment +

Analytical Approach +

Smart Grid Demonstration Program +

Workforce Training for the Electric Power Sector Program +

Standards, Interoperability, & Cybersecurity Activities +

Projects

The location, information, and data for each smart grid project are provided in this section.  
[Click for Projects](#)

- Research funded through a Smart Grid Investment Grant(SGIG) program to eEnergy Vermont, a utility consortium.
- SGIG provided substantial ARRA funding for “smart grid” deployment, but DOE dangled carrots in front of utilities who were willing to conduct “consumer behavior studies.”

# Carrots for Smart Grid Tricks!

Download our reports here:

<https://smartgrid.gov/project/vermont-transco-llc-eenergy-vermont.html>

[← Back](#)

## Vermont Transco, LLC

eEnergy Vermont

[VIEW BUILD METRICS DATA >](#)

[VIEW CONSUMER BEHAVIOR STUDY  
DESCRIPTION > ↓](#)

[VIEW PROJECT DESCRIPTION > ↓](#)

### Abstract

The Vermont Transco eEnergy Project is a collaboration of 11 publicly owned and investor-owned utilities in Vermont, as well as the statewide energy efficiency utility, Efficiency Vermont. The project deployed advanced metering infrastructure (AMI), including 305,464 smart meters across the state, and provides two-way communication between customers and the utilities. The project also installed automated voltage regulators and supervisory control and data acquisition (SCADA) equipment at selected substations. The scope of work included assessment of time-of-use and peak-time rebate programs through statistically rigorous consumer behavior studies that involved consumer web portals and in-home displays. Although all project equipment has been deployed, data gathering and analysis from the studies is ongoing.

### Related Documents

[Load Impact Analysis of Green Mountain Power Critical Peak Events, 2012 and 2013 - February 2015 ↓](#)

[Vermont Transco Green Mountain Power Interim Report - April 2012 ↓](#)

[eEnergy Vermont Case study - November 2011 ↓](#)

### At-A-Glance

**Recipient:** Vermont Transco, LLC

**HQ State:** Vermont

**NERC Region:** NPCC

**Total Budget:** \$137,767,170

**Federal Share:** \$68,883,585

**Funding Program:**

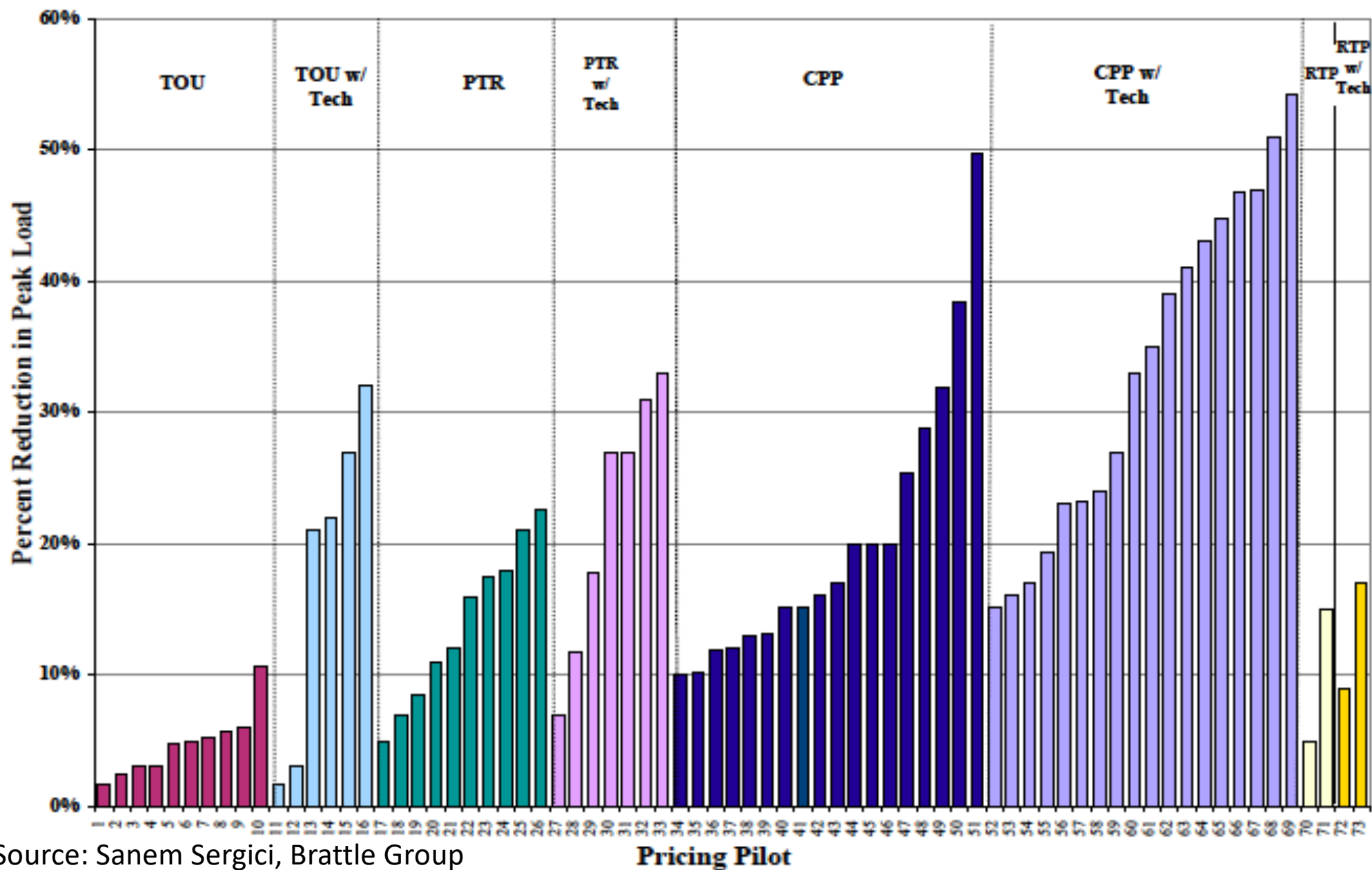
Investment Grant Program

**Project Type:**

Advanced Metering Infrastructure

Consumer Behavior Studies

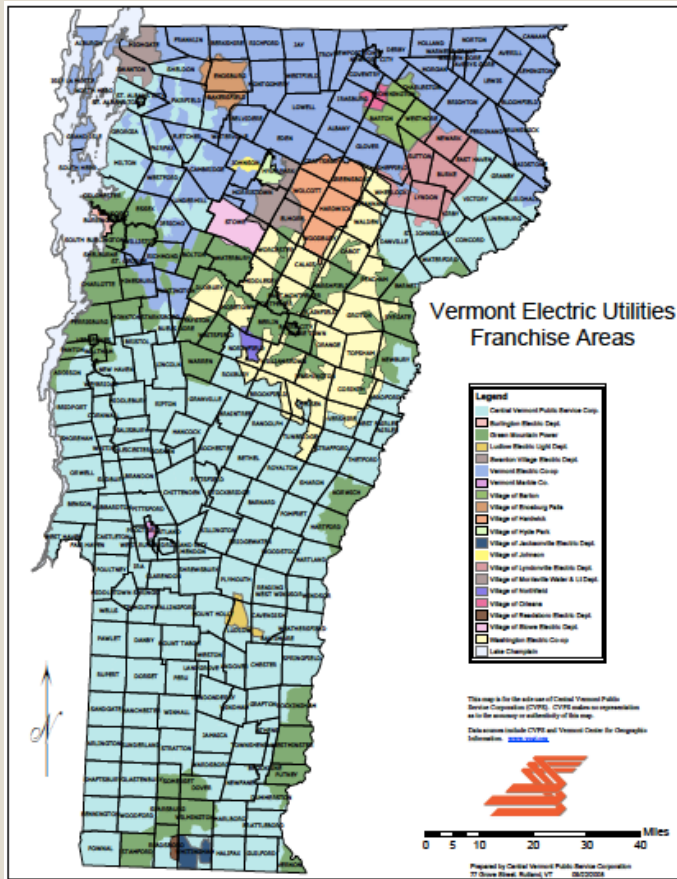
# Carrots and Sticks



Source: Sanem Sergici, Brattle Group

# eEnergy Vermont Experiment

Fall 2011



Dec. 2013

- Fall 2011: Smart meter installation begins.
- February – April 2012: Customer recruitment.
- April 2012: Smart meter installations completed. Meter data collection begins.
- August 2012: CPP and CPR customers placed on new rate; IHDs mailed to customers.
- September 14, 21, 25; Oct. 5, 2012: Year 1 events called.
- December 2012: Interim survey completed.
- July 5, 15, 16, 17, 18, 19, 2013: Year 2 events called.
- August 13, 21, 22, 28, 2013: Year 2 events called.
- Sept. 30, 2013: Meter data collection ends.
- December 2013: Post-treatment survey completed.

# eEnergy Vermont Experiment

- RCT involving 3,735 GMP residential customers in Rutland;
- Opt-in to enroll; opt-out at any time;
- Event-based study with 24-hour notification of “peak days,” rate treatments: peak pricing, peak rebates and a transition group who started on a rebate and were moved to peak pricing;
- Tech and no-tech groups;
- Notification mode choices (phone, e-mail, text message);
- Detailed pre/mid/post study surveys.

# eEnergy Vermont Experiment

Group No	Group Name	Survey	Year 1	Year 2	IHD	Notification	Required sample size
1	CPR	X	CPR	CPR		X	390
2	CPR+IHD	X	CPR	CPR	X	X	195
3	CPP	X	CPP	CPP		X	390
4	CPP+IHD	X	CPP	CPP	X	X	195
5	CPR-CPP	X	CPR	CPP		X	390
6	CPR-CPP+IHD	X	CPR	CPP	X	X	195
7	Flat+Notification	X	Flat	Flat		X	390
C1	Flat w/o Notification (Control)	X	Flat	Flat			390
C2	Control, No Survey		Flat	Flat			1200
<b>Totals</b>							<b>3735</b>

# eEnergy Vermont Experiment

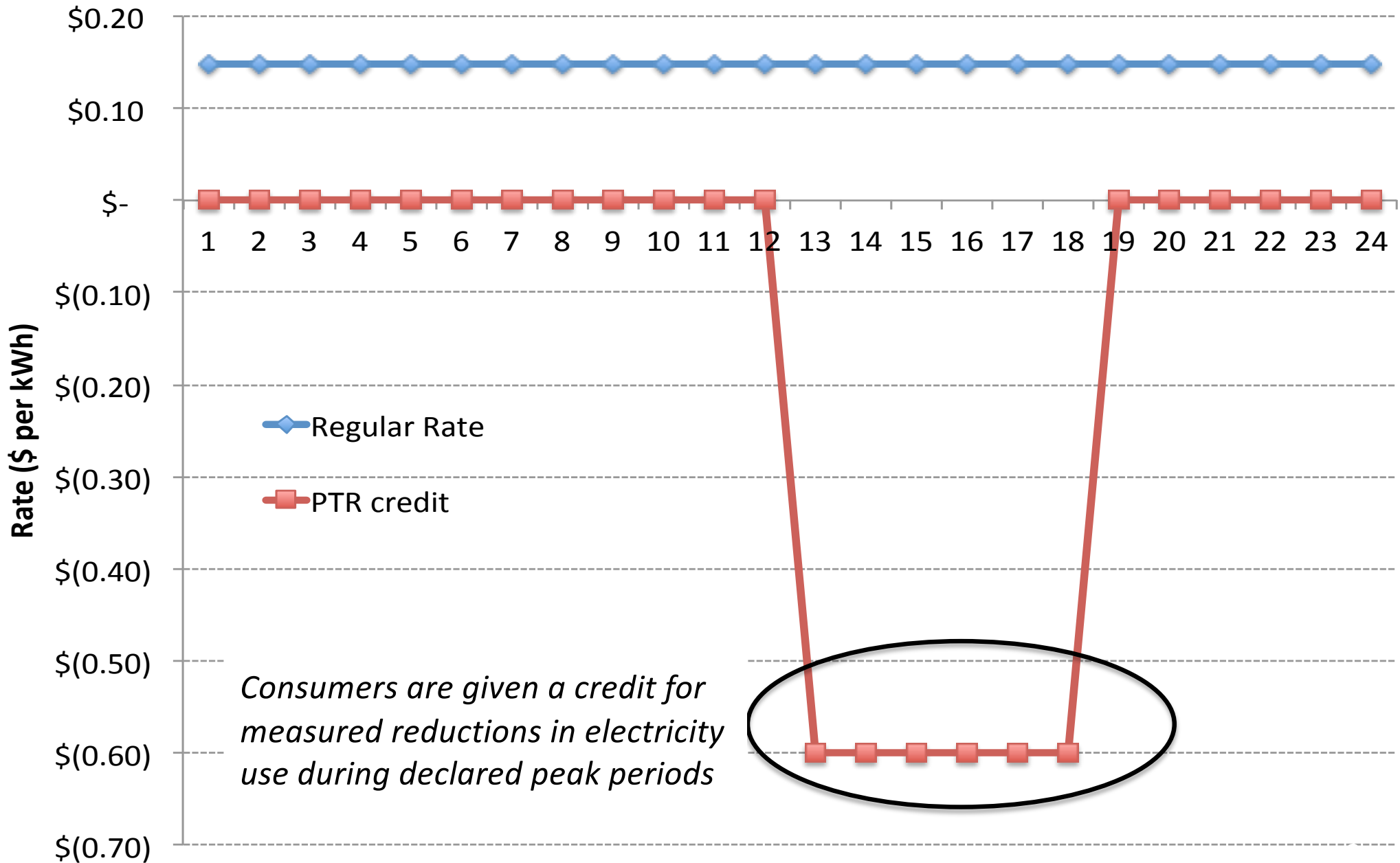
Rate/Information Treatment	Technology Treatment
Critical Peak Price (CPP)	IHD
	No IHD
Critical Peak Rebate (CPR)	IHD
	No IHD
CPR in Year 1, CPP in Year 2	IHD
	No IHD
Flat Rate w/Notification	No IHD
Flat Rate w/o Notification	No IHD

~ 4,000 customers involved in the pilot.

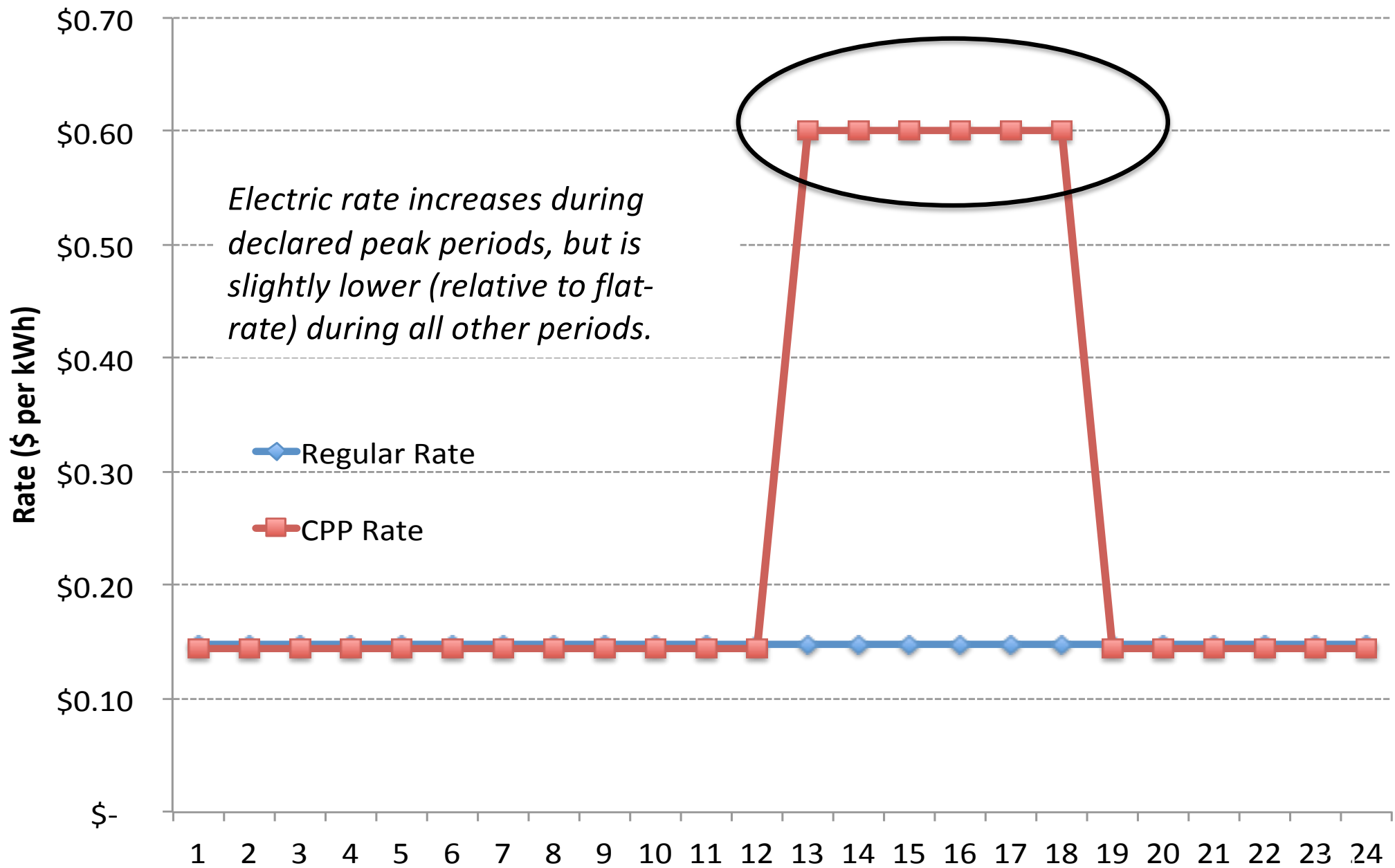
A “Hawthorne” group was created but no Hawthorne effect detected.



# The Carrot: Critical Peak Rebates (CPR)



# The Stick: Critical Peak Pricing (CPP)



# In Home Device (Circa the Stone Age)

TE-N-DRIL™



**Insight**  
In-Home Display

## Overview

- Displays current household energy use in both kilowatts and dollars-per-hour
- Displays current day accumulated energy usage and compares cost with previous day's cost

# CPR, CPP and GMP

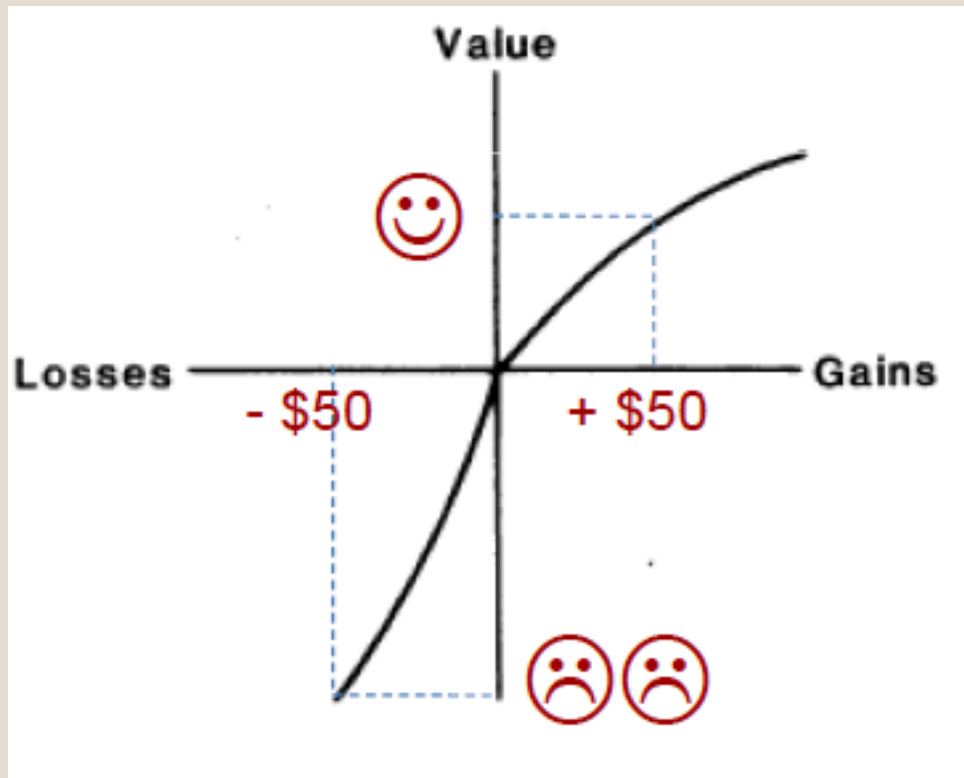


Image source: NPR

- Some utilities have run pilot programs that use peak-time rebates. Others have used critical-peak pricing.
- GMP was convinced to do both. This made their state regulator confused, and a little irritated. Aren't peak prices and peak rebates basically the same thing? Why punish the poor people of Vermont?

# Framing Gains and Losses

“The aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount.” - Kahneman and Tversky, 1979



Graphic: Annika Todd, LBNL

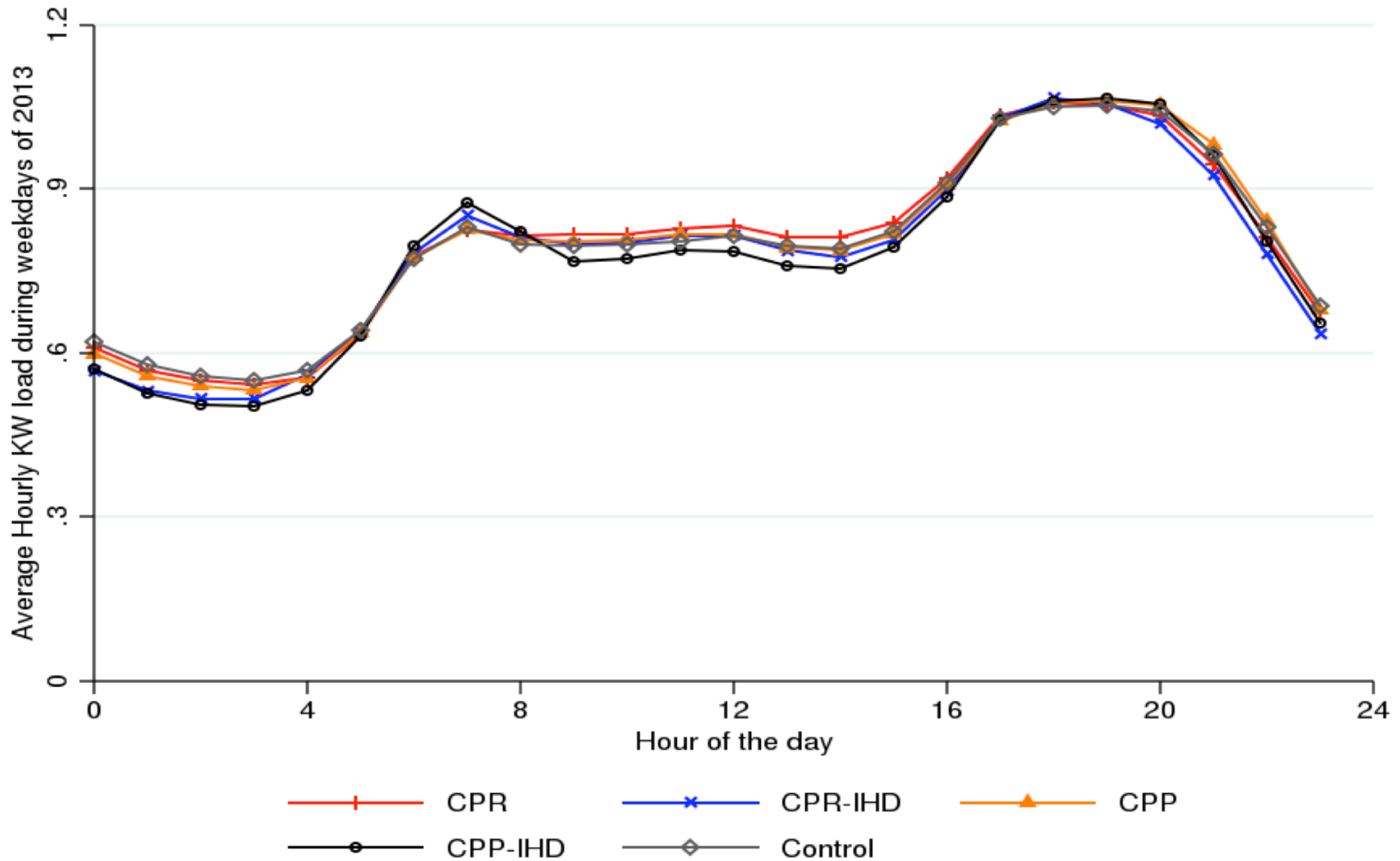
- Avoiding a loss is somehow preferred to achieving a gain that is identical in magnitude.
- Suggests that we should expect larger savings from CPP than CPR
- Can ratepayers be trained to like the stick?

# Data and Estimation

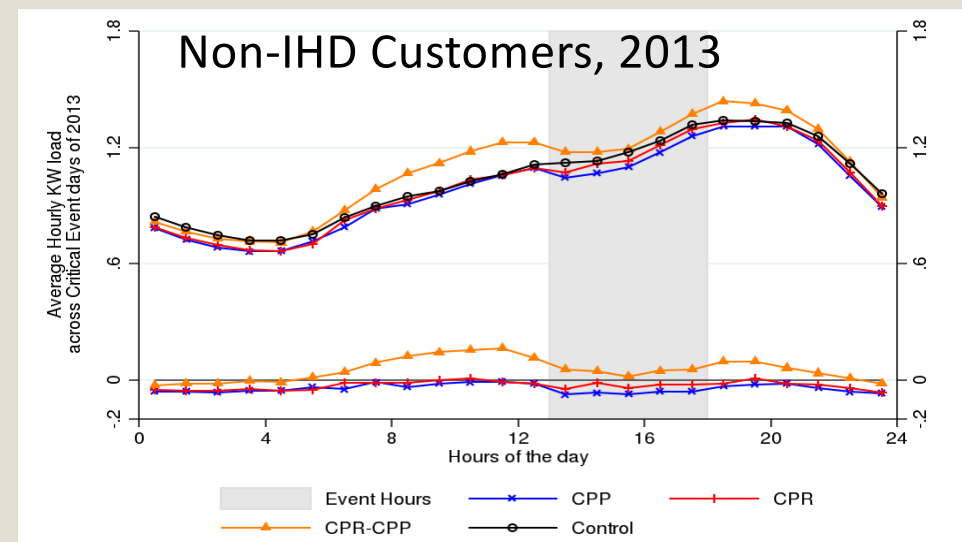
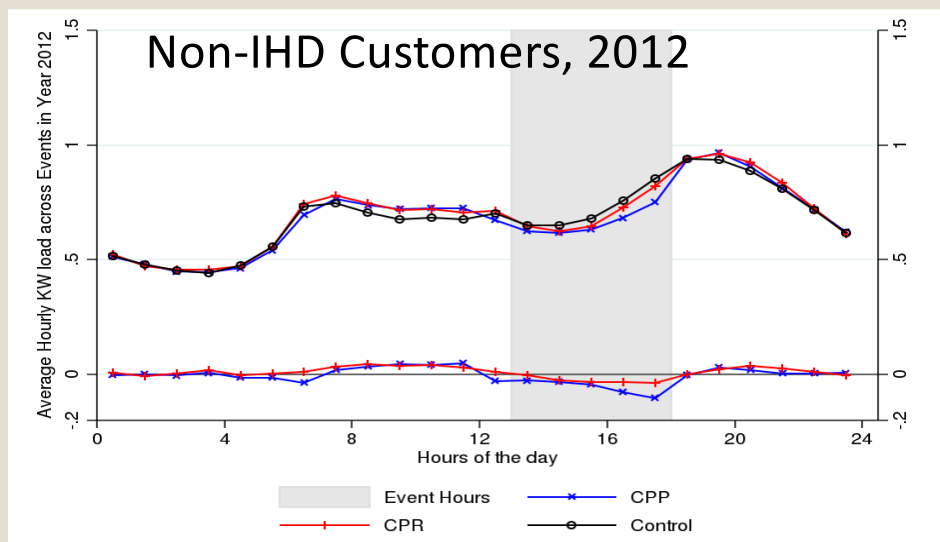
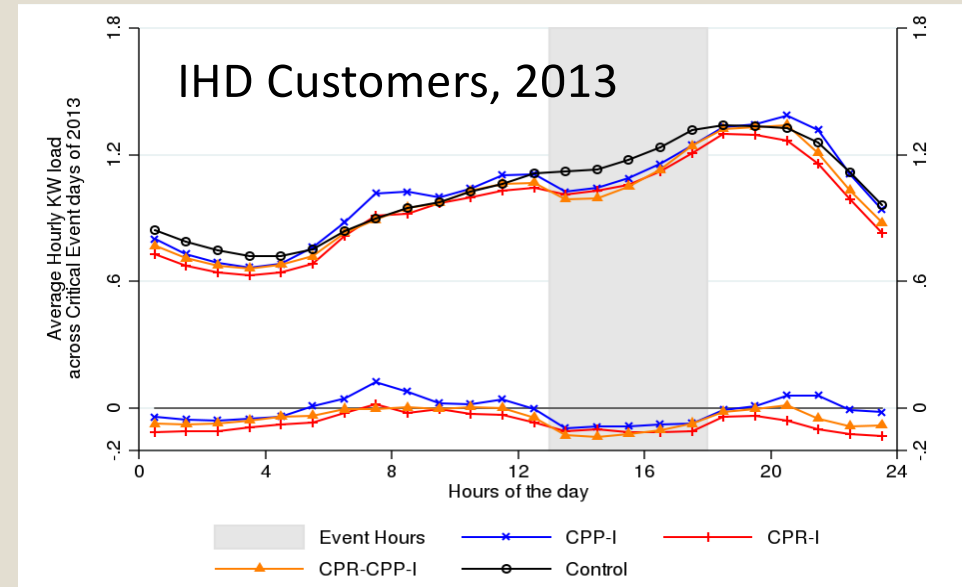
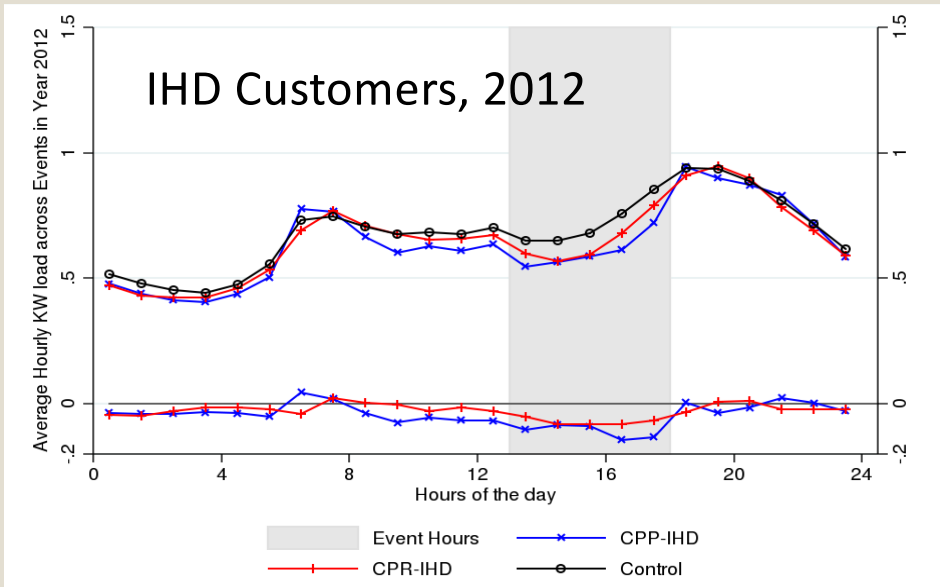
$$\begin{aligned} y_{it} = & \beta + \sum_j \beta_j T_{ij} + \sum_k \beta_k^{DB} DB_{ik} + \sum_k \beta_k^{DE} DE_{ik} + \sum_k \beta_k^{DA} DA_{ik} \\ & + \sum_j \sum_k \beta_{jk}^{DE(k)} T_{ij} DB_{kt} + \sum_j \sum_k \beta_{jk}^{DB(k)} T_{ij} DE_{kt} + \sum_j \sum_k \beta_{jk}^{DB(k)} T_{ij} DA_{kt} \\ & + \beta_t^{CD} CD_t + \beta_t^{HI} HI_t + \varepsilon_{it} \end{aligned}$$

- 15-minute interval meter data for several thousand GMP residential customers in Rutland
- Plus some socio-economic data (house size, appliance stock, income, education, household size, etc)

# Weekday Load Shapes

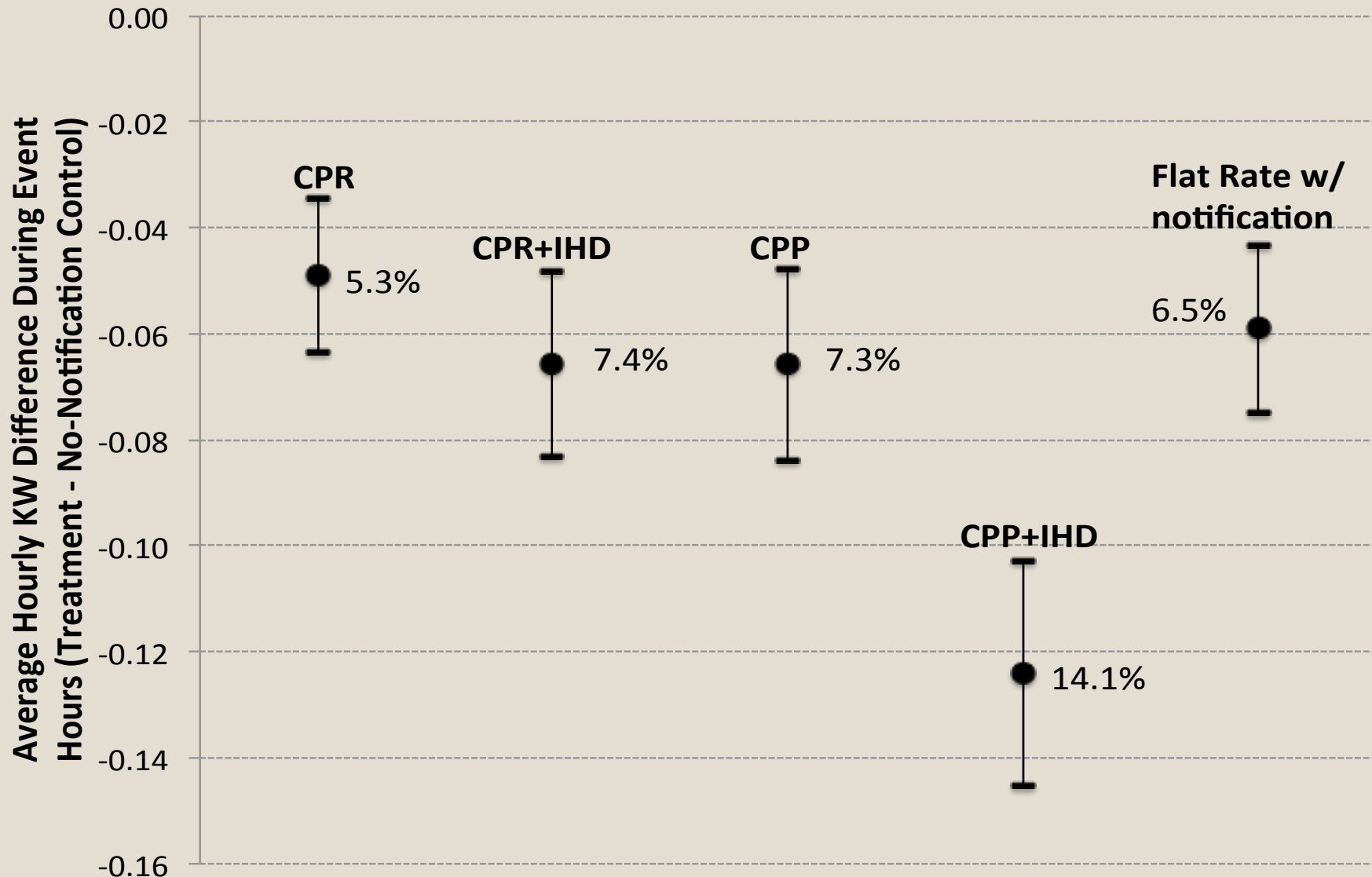


# Event-Day Behavior, 2012 and 2013





# Average Peak Time Load Reductions

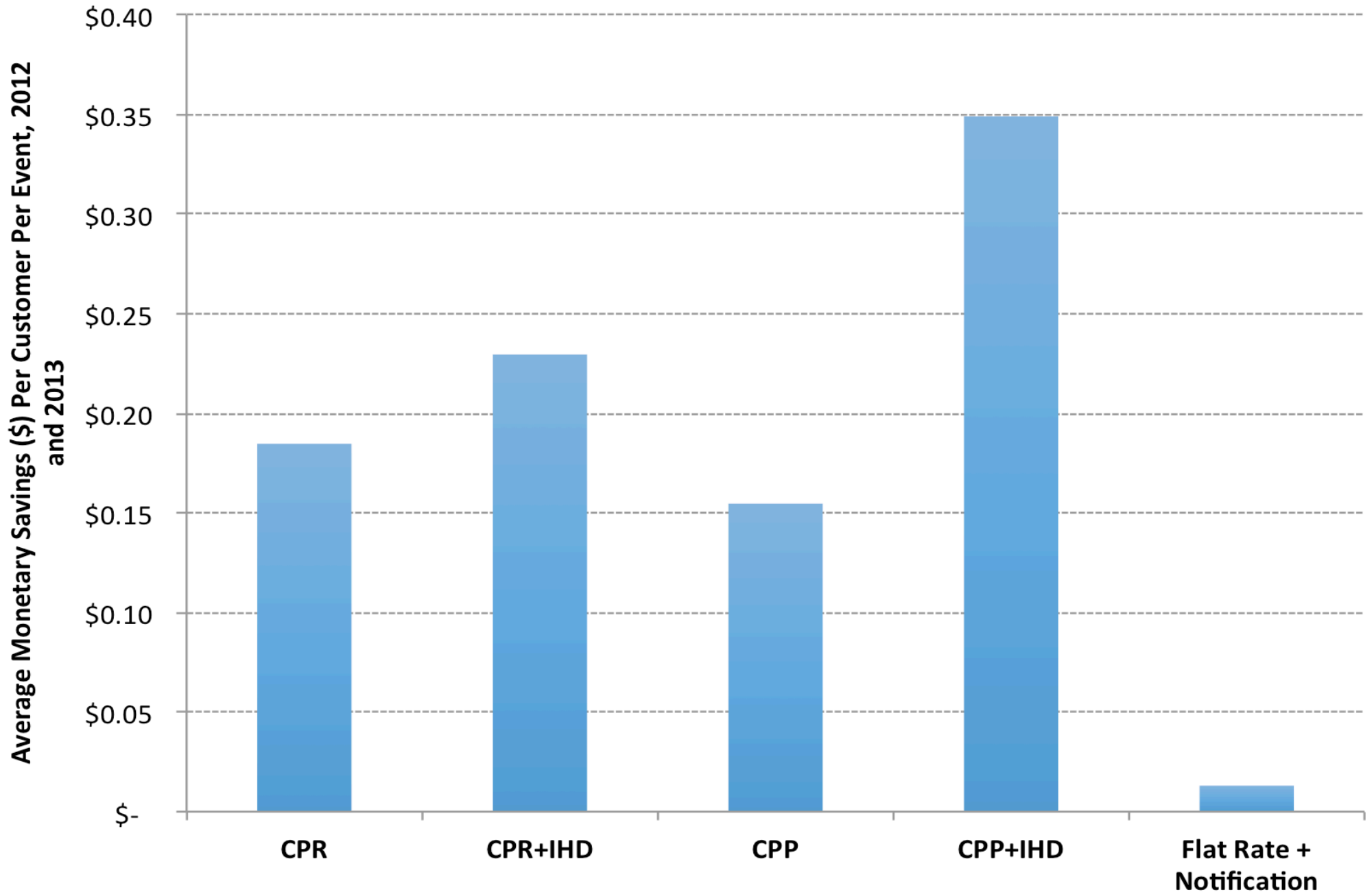


# Before/During/After Event

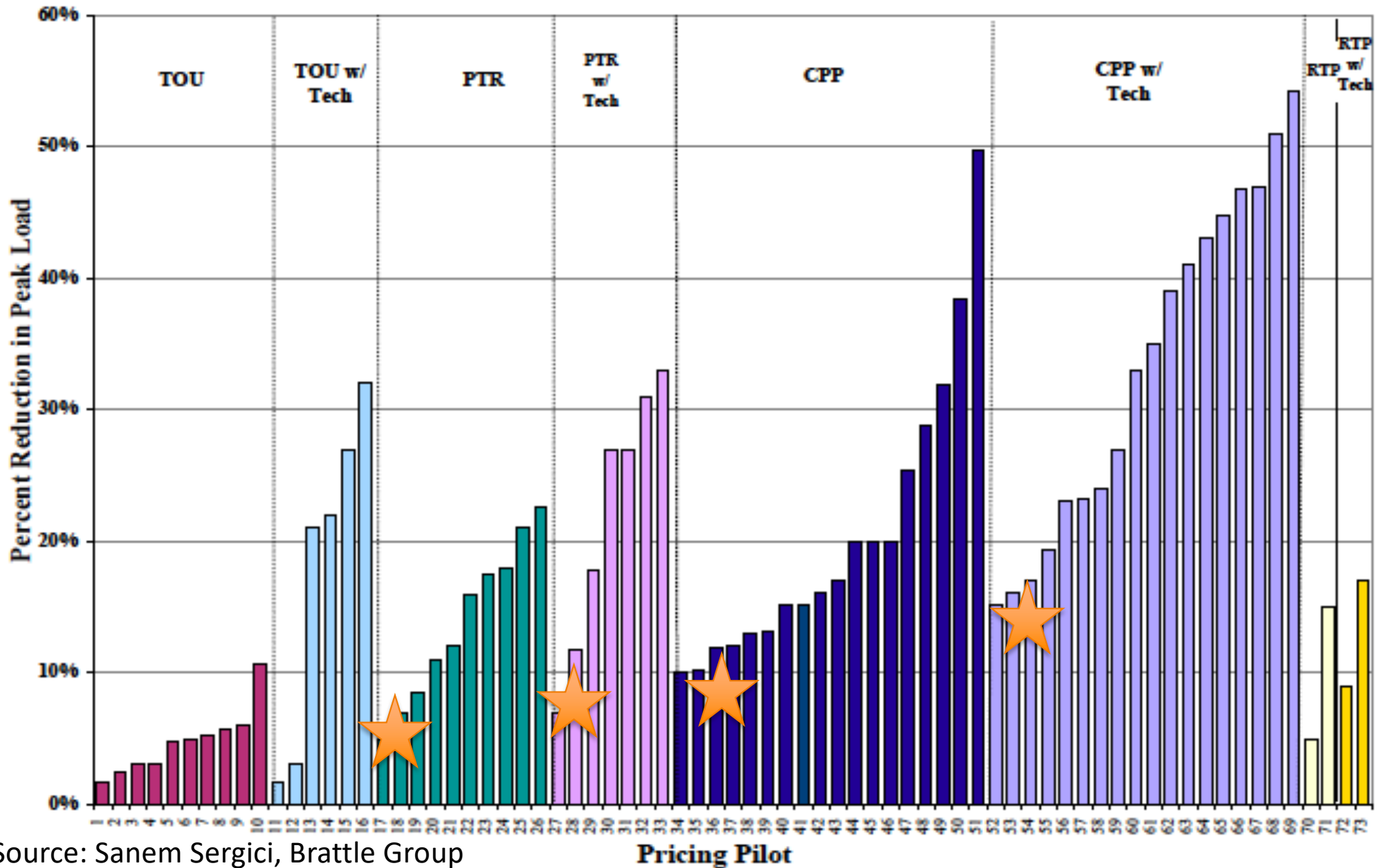
**Table E-1: Summary of load impacts (percentage reductions relative to the no-notification control group), 2012 and 2013**

Treatment	2012			2013		
	Before	During	After	Before	During	After
Flat Rate w/ Notification	-6.45%	-3.38%	0.15%	-3.81%	-8.18%	-5.81%
CPR-CPR	-4.72%	-5.29%	-0.57%	1.06%	-2.17%	-1.52%
CPR-CPR w/IHD	-2.65%	-7.64%	3.41%	2.41%	-9.55%	-5.77%
CPP-CPP	-1.51%	-7.42%	1.77%	-0.56%	-7.46%	-3.79%
CPP-CPP w/ IHD	-8.67%	<b>-11.80%</b>	2.68%	3.56%	<b>-14.48%</b>	-0.67%
CPR-CPP	-4.29%	-8.57%	-1.27%	<b>16.86%</b>	1.40%	1.90%
CPR-CPP w/ IHD	-5.29%	-6.24%	-4.40%	1.82%	-16.40%	-3.43%

# Monetary Savings

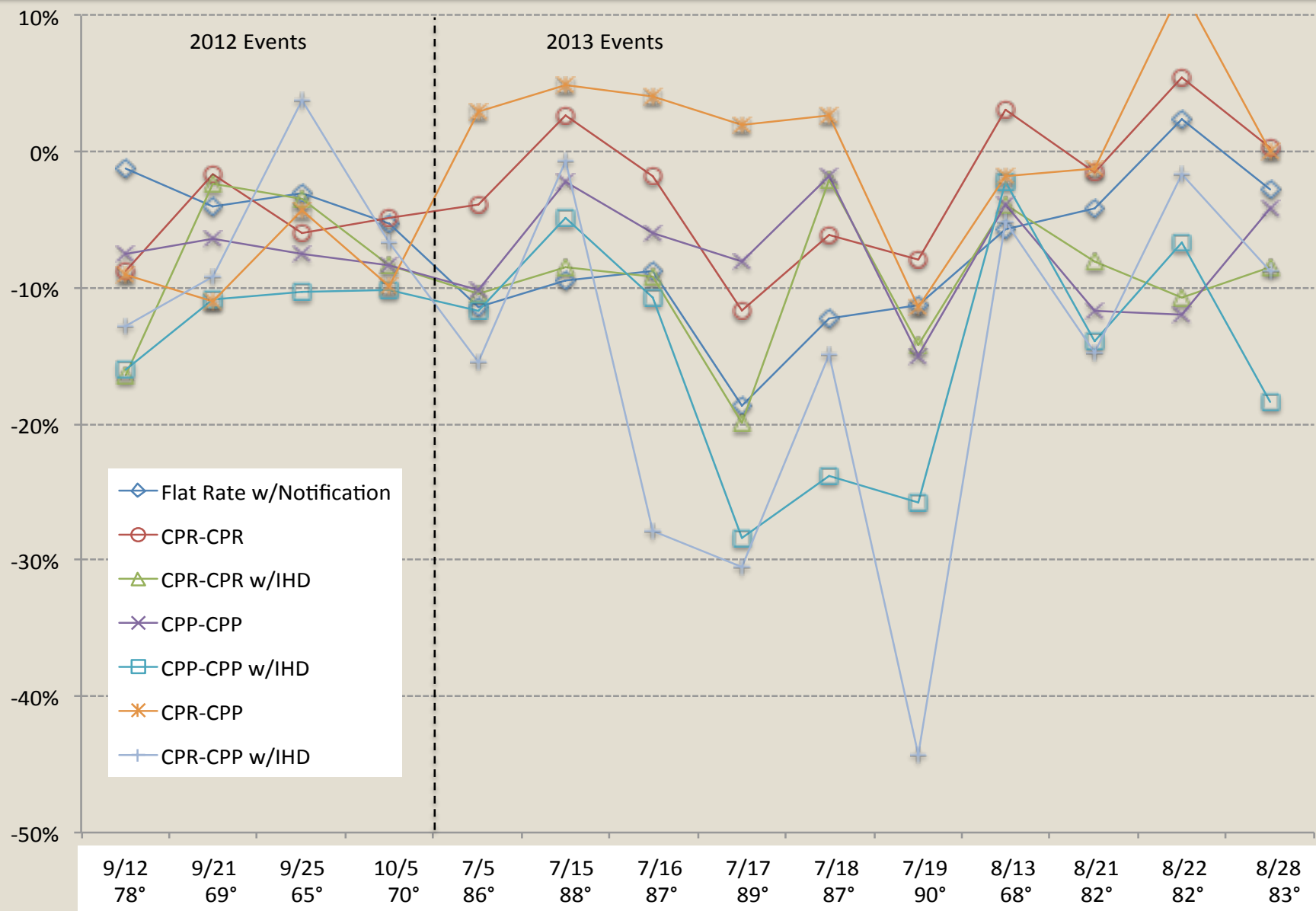


# So, What Did We Learn?

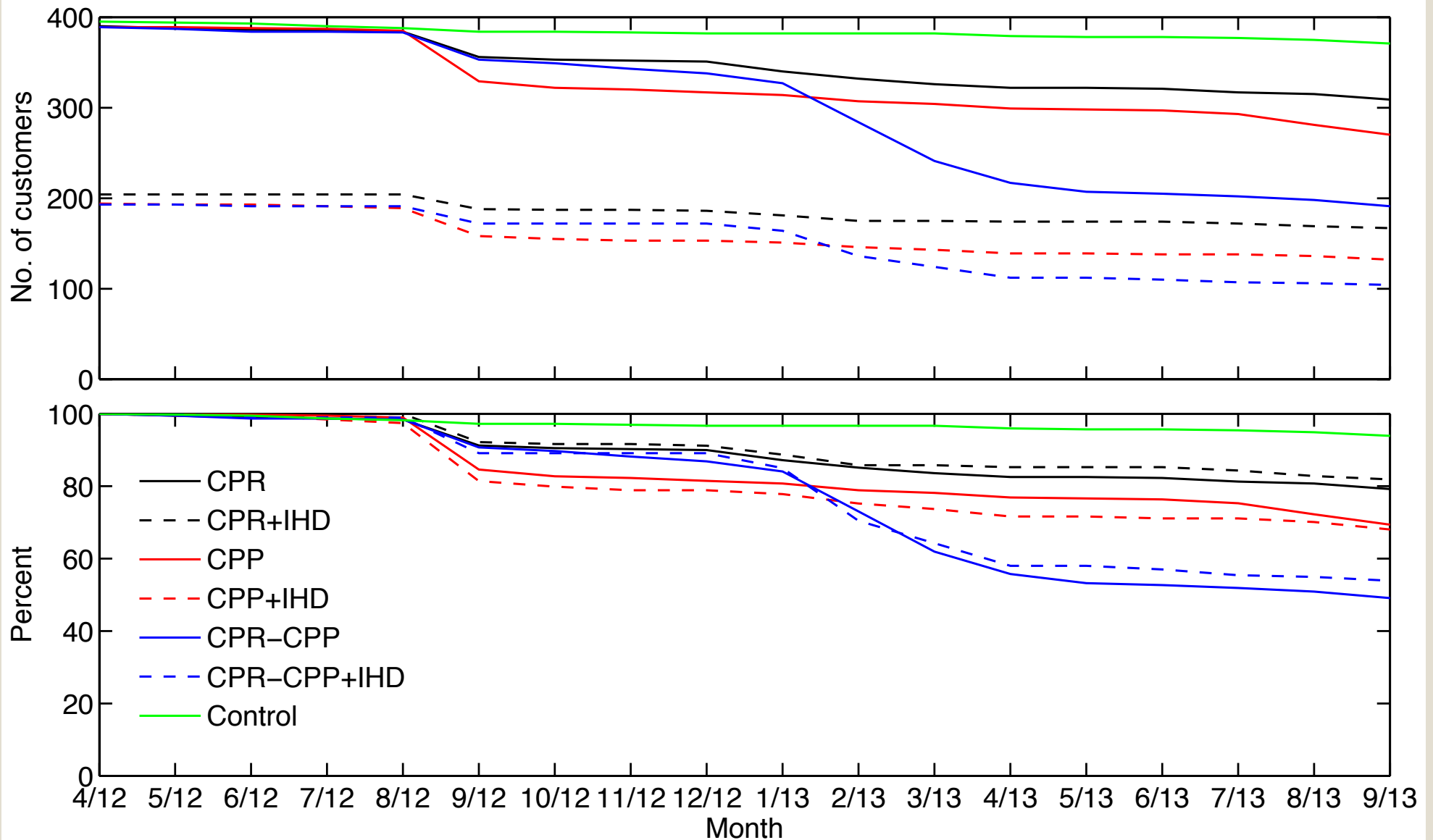


Source: Sanem Sergici, Brattle Group

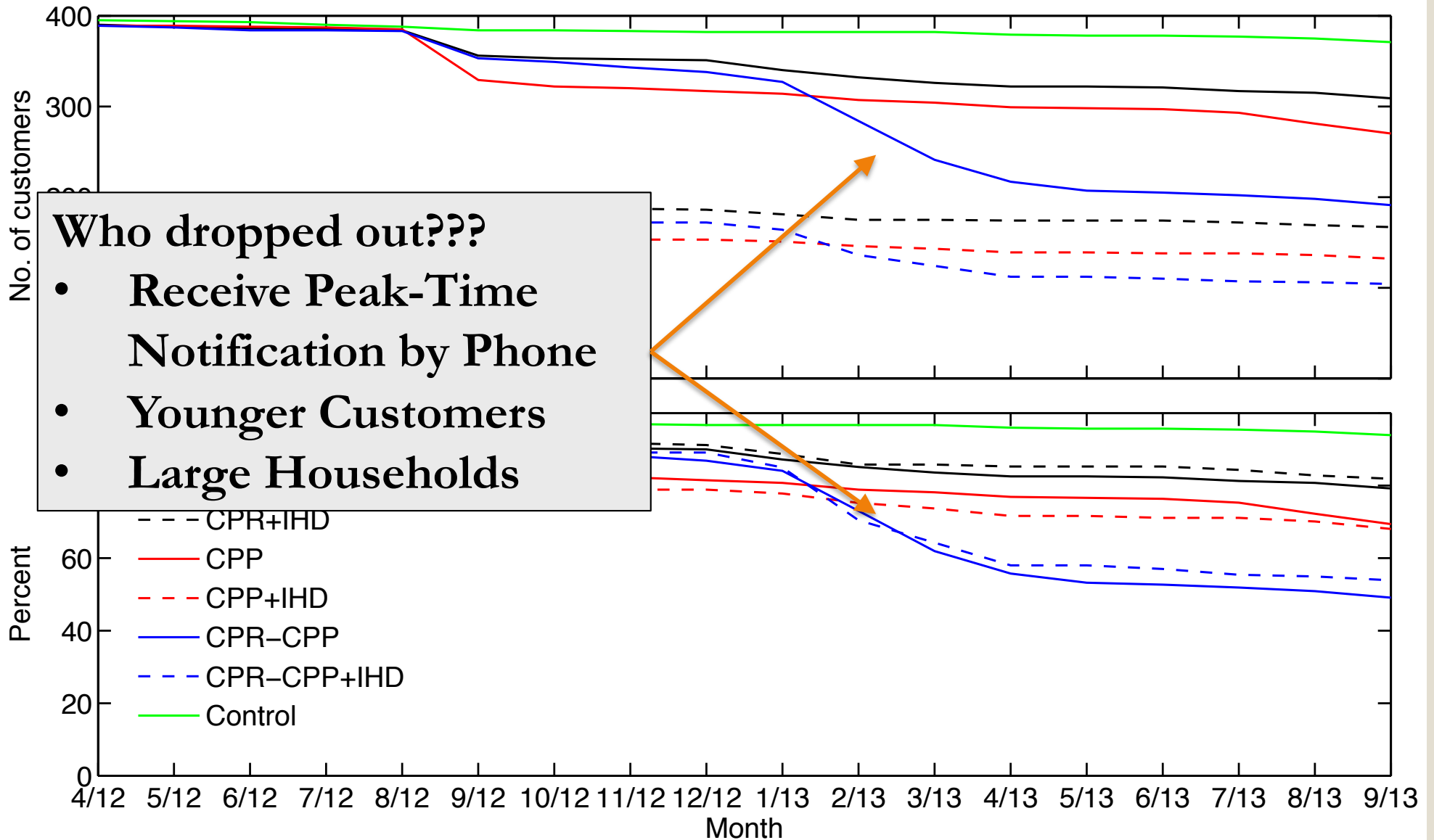
# Capacity Value of Retail DR



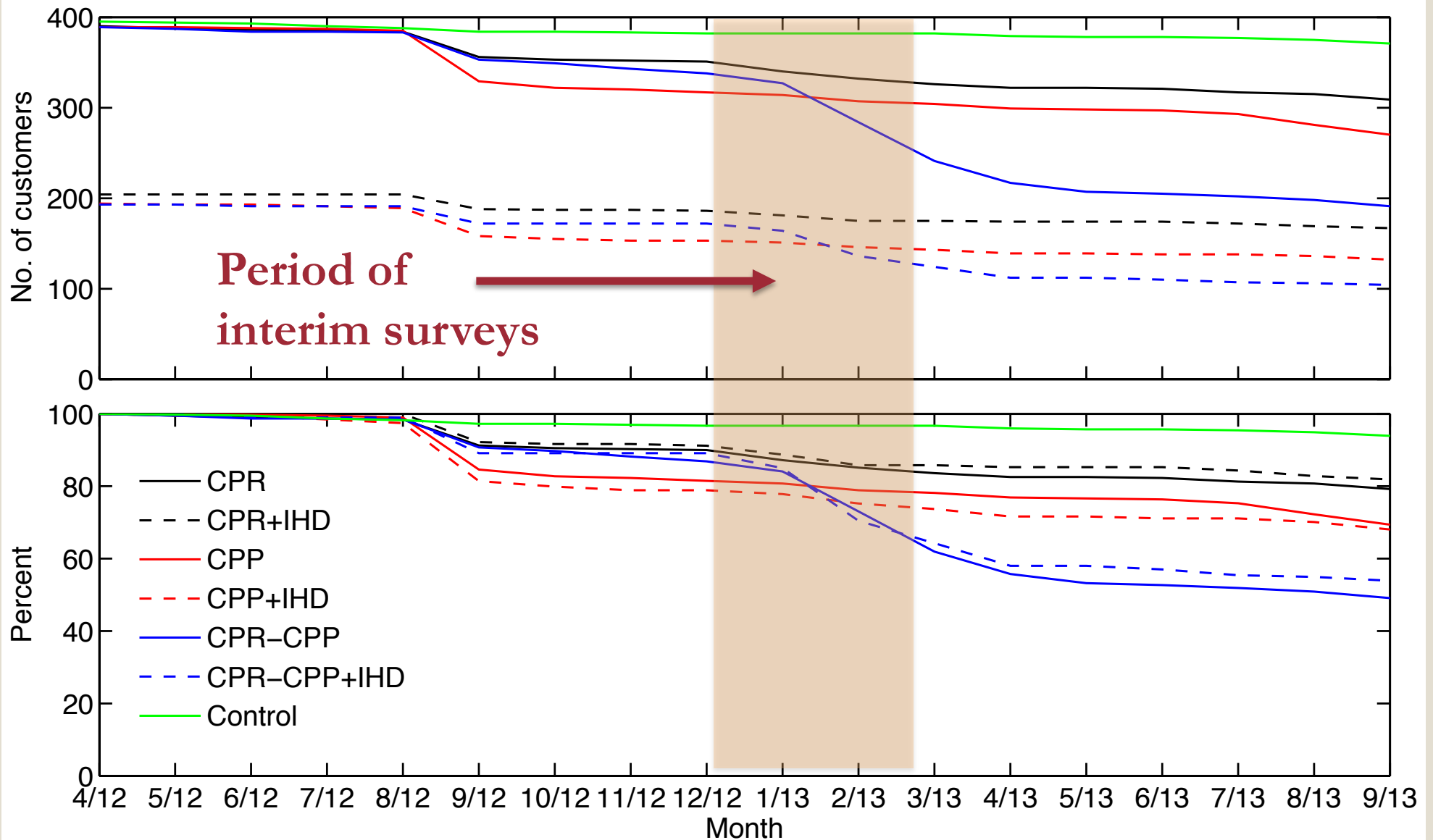
# How Not to be Popular!



# How Not to be Popular!

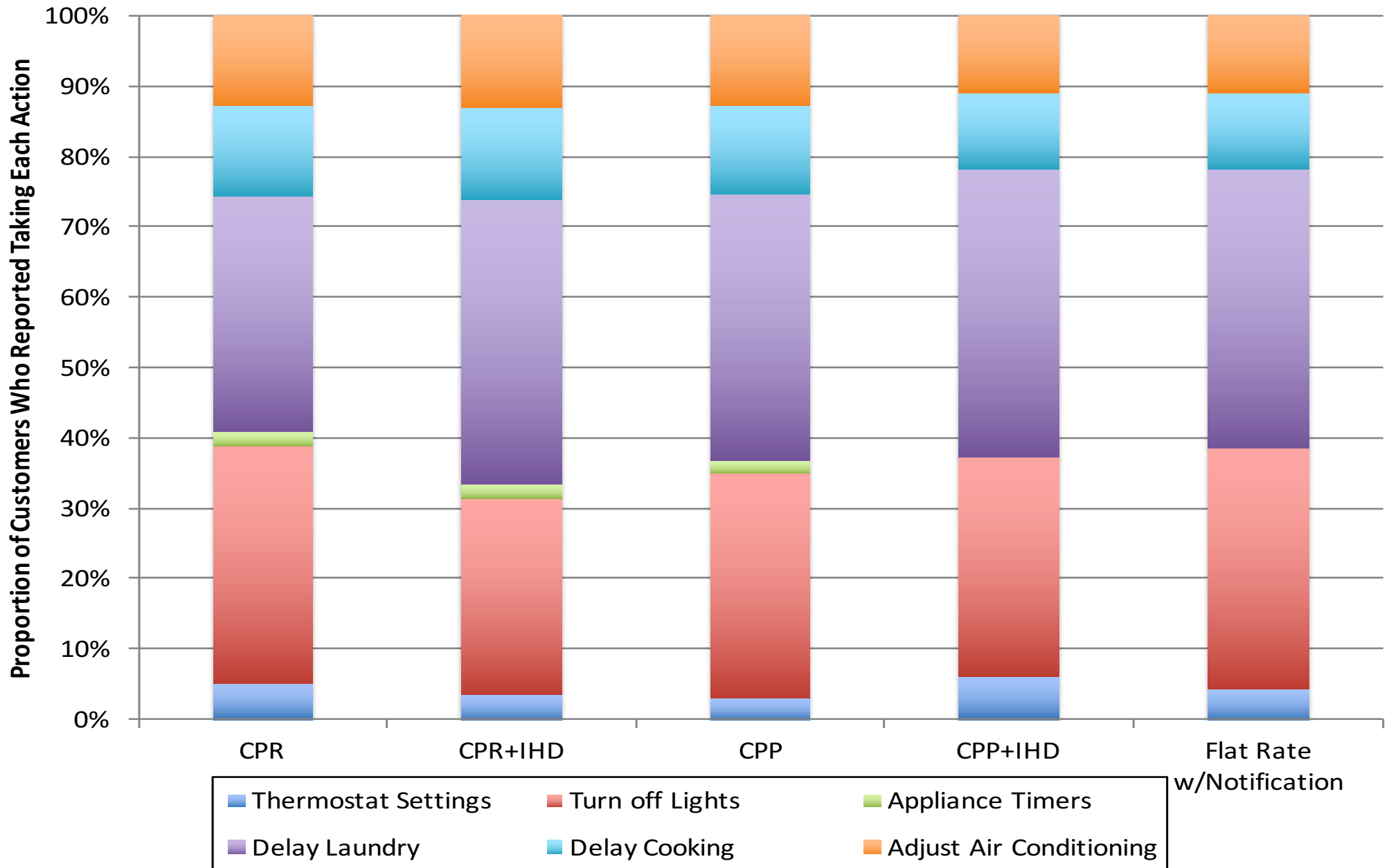


# How Not to be Popular!

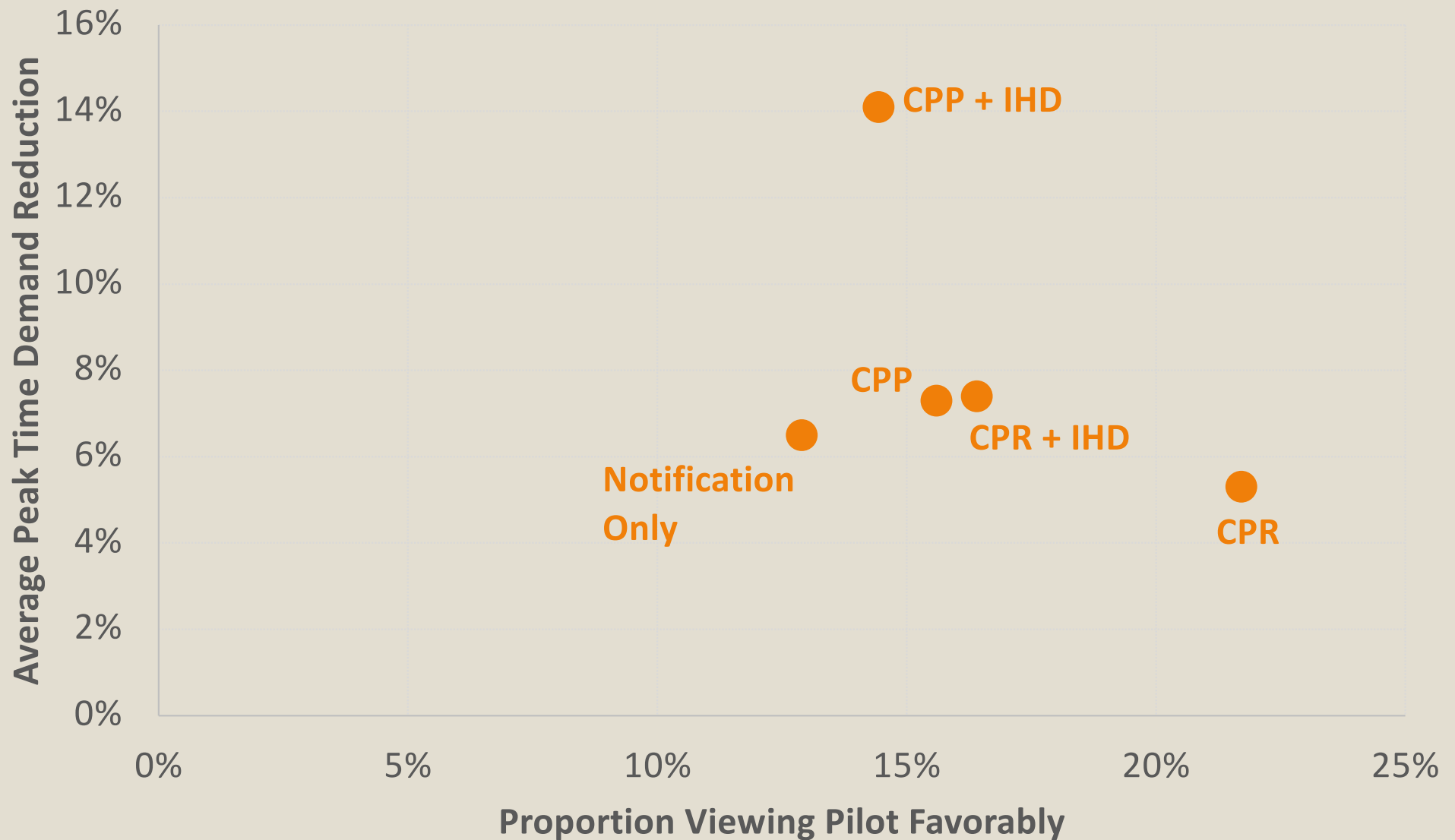




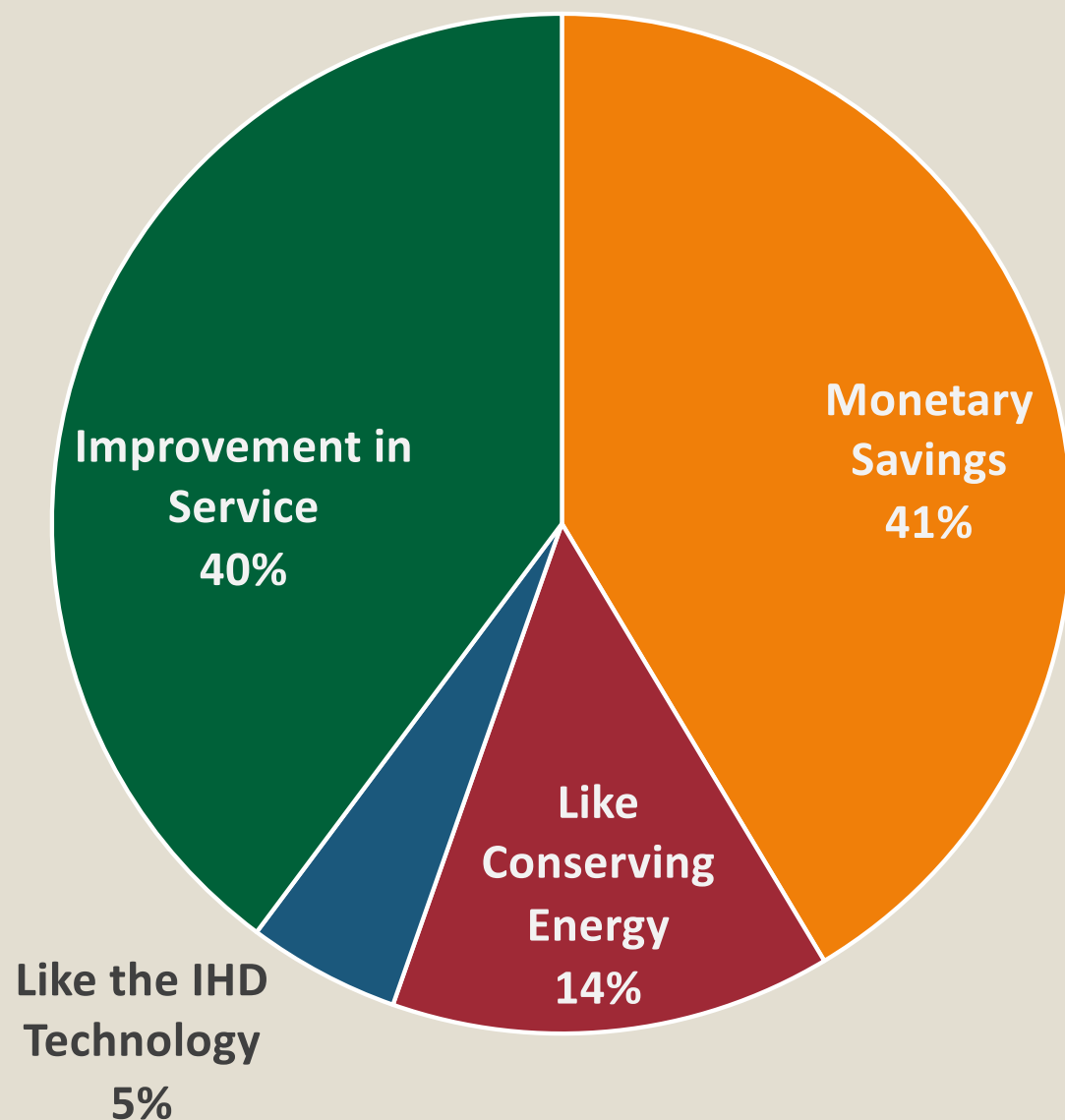
# Actions Reported



# Efficacy-Popularity Frontier



# How Do Consumers Value Smart Grids?



“They knew where we were when we had power outages”

--GMP customer  
(without IHD)



# Utility Lessons

**Sticks work better than carrots...**

*...but sticks are unpopular, especially after dangling carrots before customers/regulators.*

**Customers DO respond to incentives...**

*...but not persistently enough to have much (retail) capacity value.*

**Information CAN be useful...**

*...but the supporting systems need to become as EASY as making coffee.*

# A Final Musing



- Why do *households* care about the carrot or the stick?
- GMP customers each saved *tens of cents* during every peak event!
- What motivates customers? Does the penny make the conservation choice more or less complicated?

# Thank You!

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