



SMART GRID INVESTMENT GRANT

CONSUMER BEHAVIOR STUDY ANALYSIS

Customer Acceptance, Retention and Response to Time-based Rates at 10 U.S. Utilities

Charles Goldman
Lawrence Berkeley National Laboratory

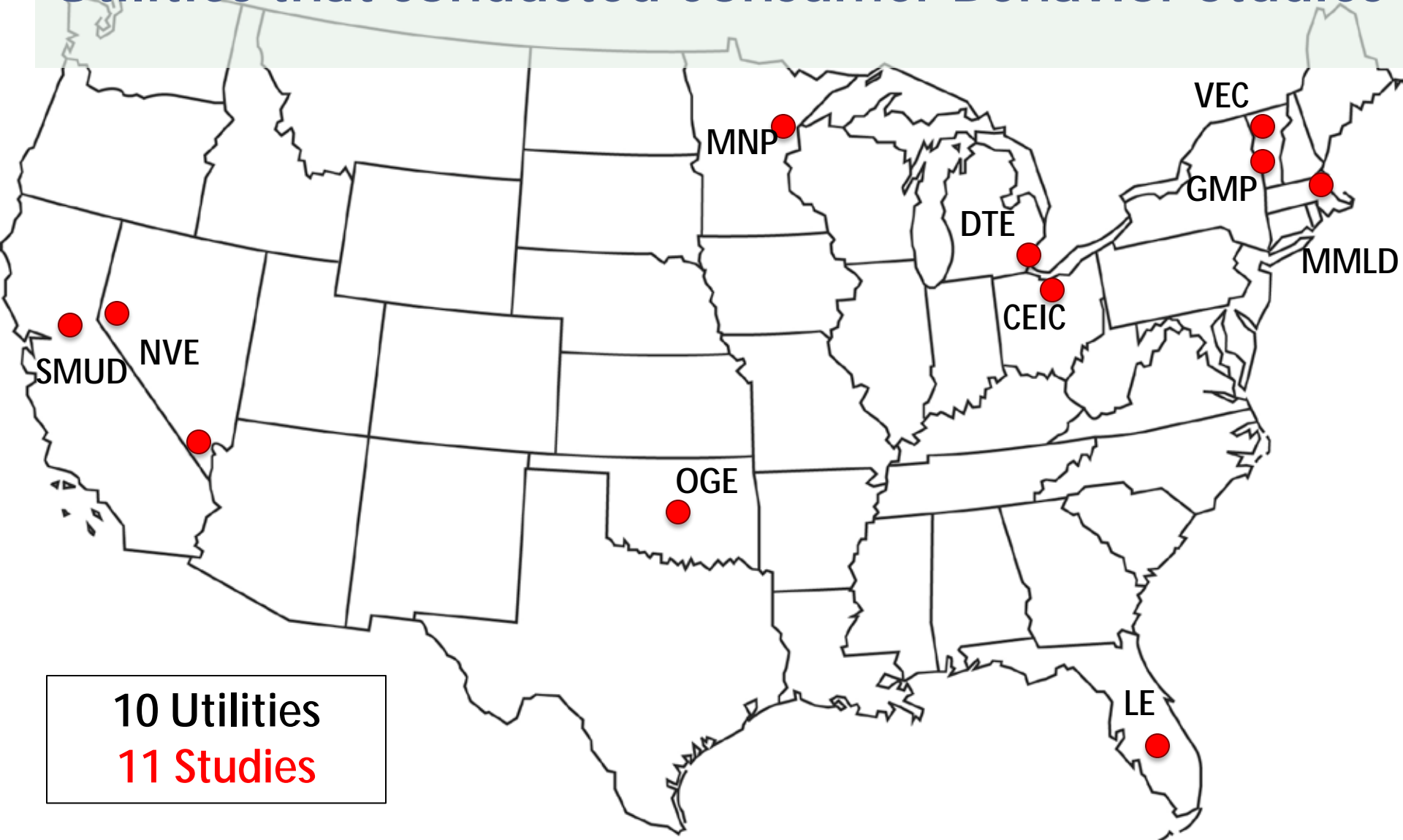
September 10, 2015
IRGC & EPFL Demand Response Conference

Outline of Talk

- **Background on SGIG CBS Projects at 10 utilities**
- **Highlights of Results**
 - Recruitment Approaches
 - Rebates vs. Pricing
 - Information and Control Technology
- **Impact of Pilots: Utility follow-up actions**



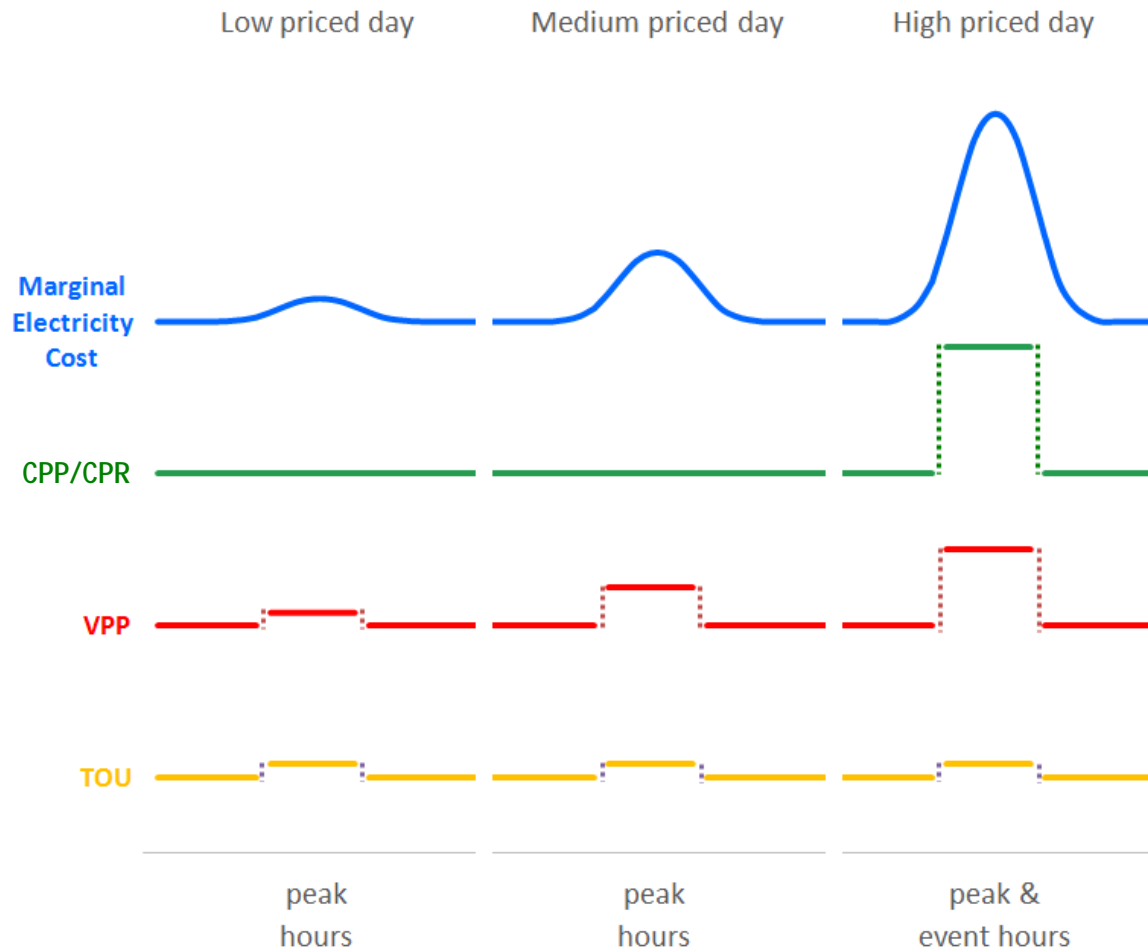
Utilities that conducted Consumer Behavior Studies



10 Utilities
11 Studies



Rate Treatments Included in Studies



Under CPP/CPR, event hours are set one day ahead and the utility either provides a rebate (CPR) or increases the commodity price (CPP) to induce a load response

Under VPP, peak *hours* are defined in advance, and the peak *price* is variable and set one day ahead (based on the wholesale price forecast)

Under TOU, the peak *hours* and *price* are static and pre-determined in advance



Customer Technology Types

Information Technology

In-Home
Displays (IHD)



Control Technology

Programmable
Communicating
Thermostats (PCT)



Study Overview

	CEIC	DTE	GMP	LE	MMLD	MP	NVE	OG&E	SMUD	VEC
Rate Treatments										
CPP										
TOU										
VPP										
CPR										
Non-Rate Treatments										
IHD										
PCT										
Education										
Recruitment Approaches										
Opt-In										
Opt-Out										

Utility Abbreviations: Cleveland Electric Illuminating Company (CEIC), DTE Energy (DTE), Green Mountain Power (GMP), Lakeland Electric (LE), Marblehead Municipal Light Department (MMLD), Minnesota Power (MP), NV Energy (NVE), Oklahoma Gas and Electric (OG&E), Sacramento Municipal Utility District (SMUD), Vermont Electric Cooperative (VEC)



Outline

- Background on SGIG CBS Projects
- Highlights
 - Recruitment Approaches
 - Rebates vs. Pricing
 - Information and Control Technology



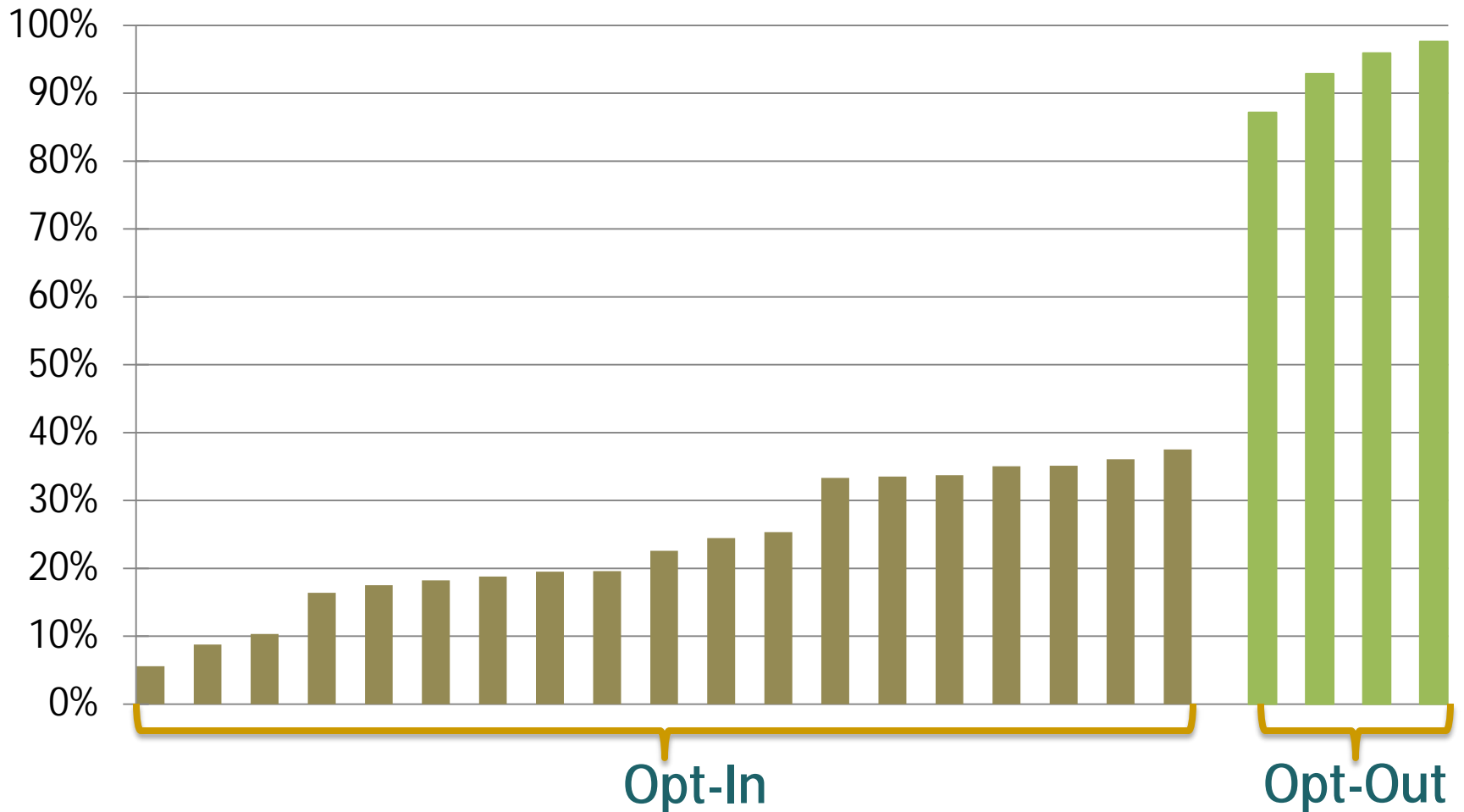
Opt-In vs. Opt-Out Policy Issues

- Declining costs for AMI reduce barriers to broad deployment of time-based rates (TBR) for all customers
- Some consumer advocates and utilities are concerned about using an opt-out method for exposing customers to TBR
 - Are you manipulating people onto a rate that:
 - They don't want, and will make them angry and complain
 - Will hurt them financially or otherwise
 - They won't be aware of until it's too late
 - Won't respond at all



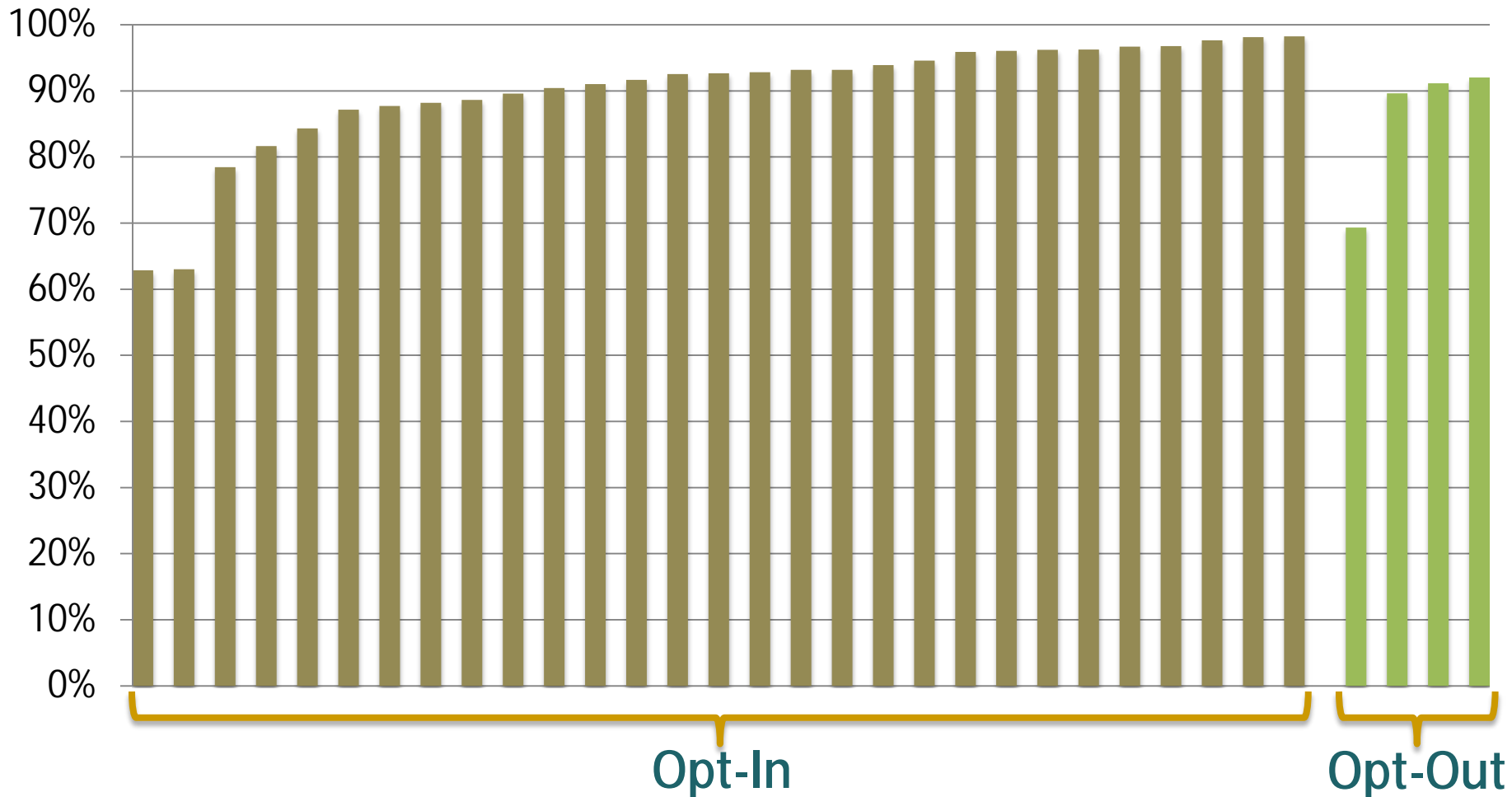
Enrollment Rates

Opt-out > Opt-In (All studies)



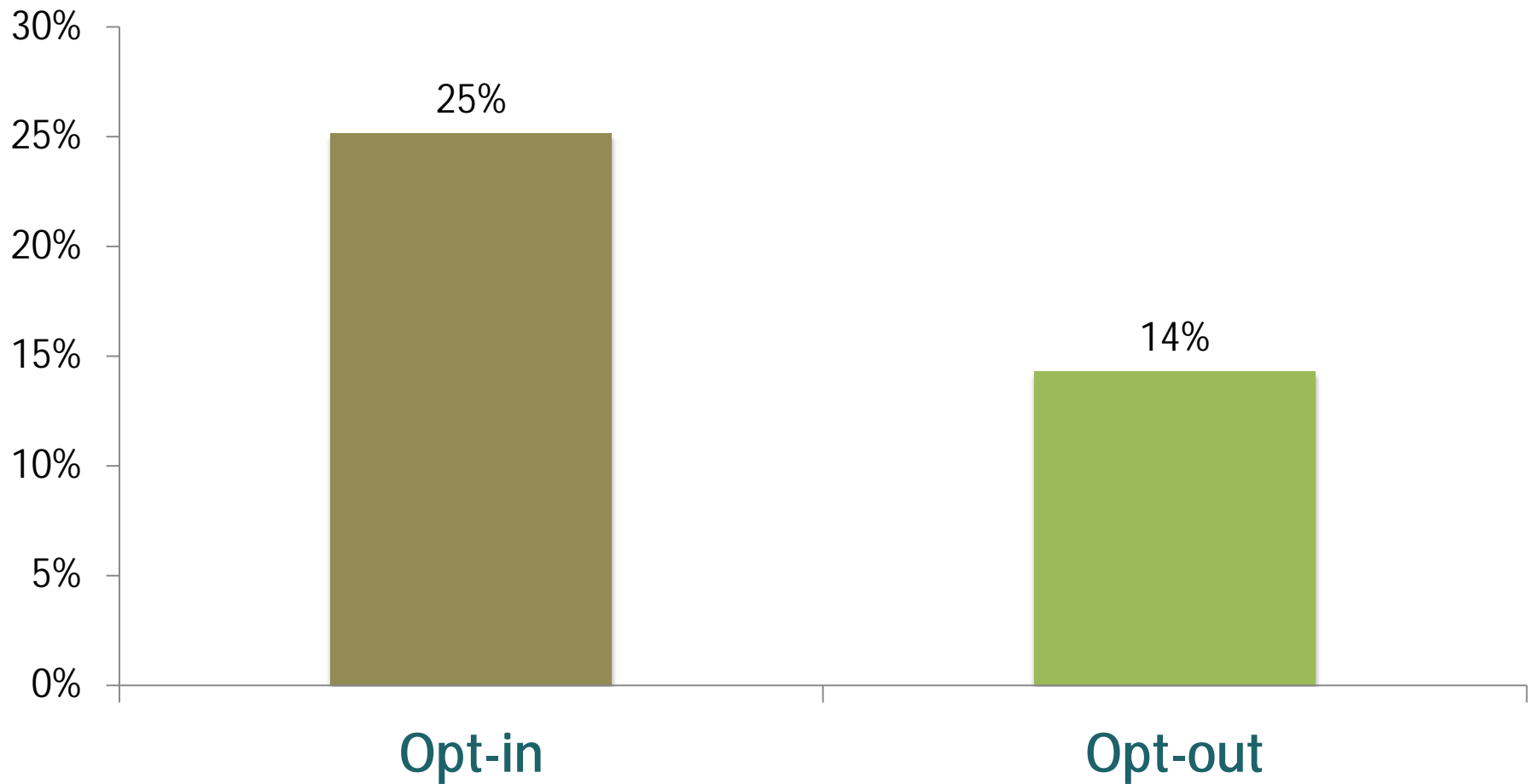
Retention Rates

Opt-in = Opt-Out (All studies)



Peak Load Response during Events

Opt-in > Opt-out (SMUD)



Recruitment Approach Affects Cost-Effectiveness (SMUD)

Recruitment Approach	Scenario Offer	Benefit-Cost Ratio
Opt-in	TOU, no IHD	1.19
	TOU, with IHD	0.74
	CPP, no IHD	2.05
	CPP, with IHD	1.30
Opt-Out	TOU, with IHD	2.04
	CPP, with IHD	2.22
	TOU-CPP, with IHD	2.49



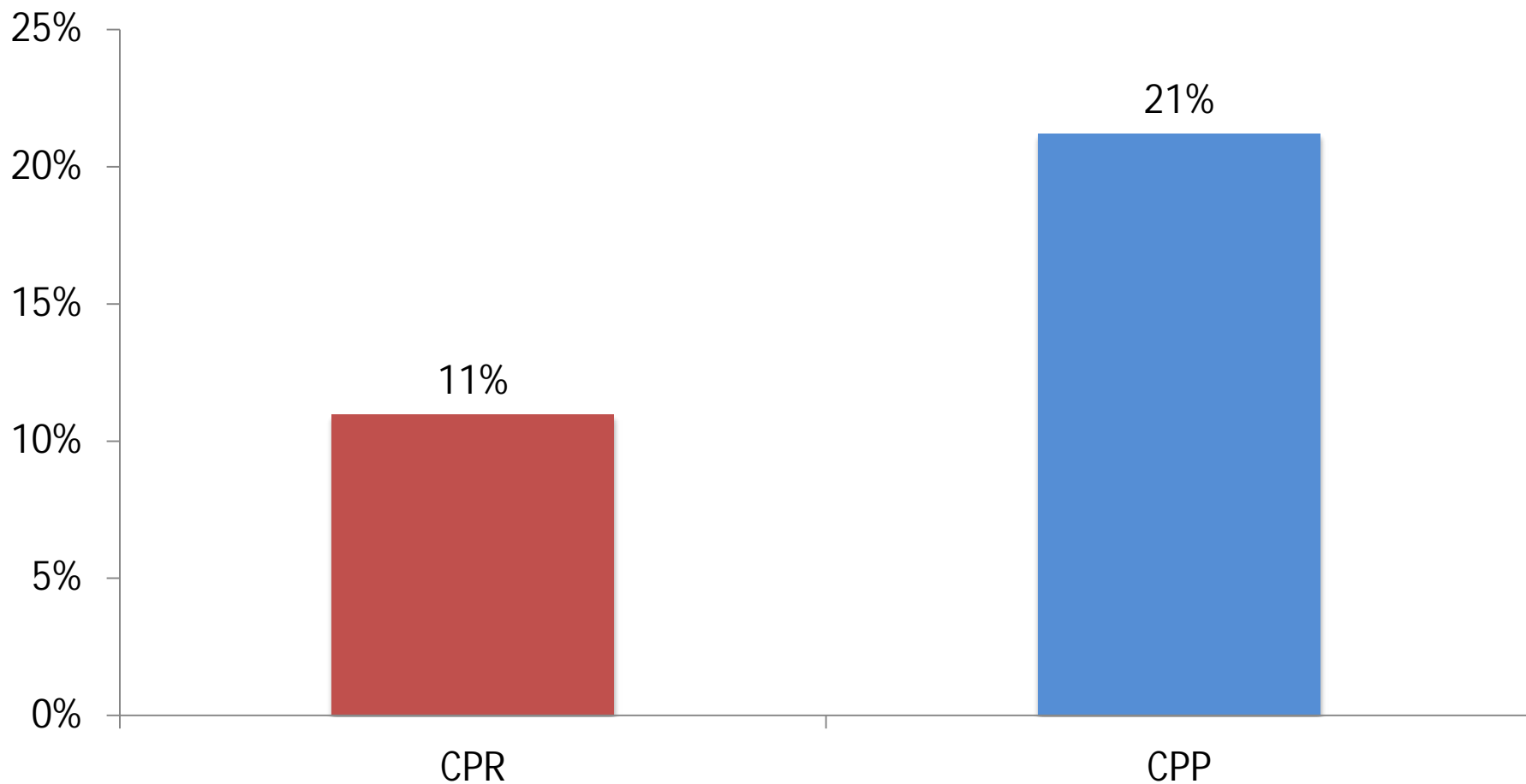
Prices vs. Rebates Policy Issues

- Economists prefer efficient price signals to inform customer usage decisions
 - Price goes up, demand should go down
- Some consumer advocates (and utilities) are concerned about relying on time-based rates
 - Bill volatility during high priced events/seasons
 - Lack of ability to respond to mitigate bill impacts
 - Prefer to pay rebates for load reductions than exposing 100% of a customers' load to high prices
- These programs are intended to reduce peak demands which drive capacity obligations for utilities
 - The variability and dependability of the load response is important to assess value and cost effectiveness

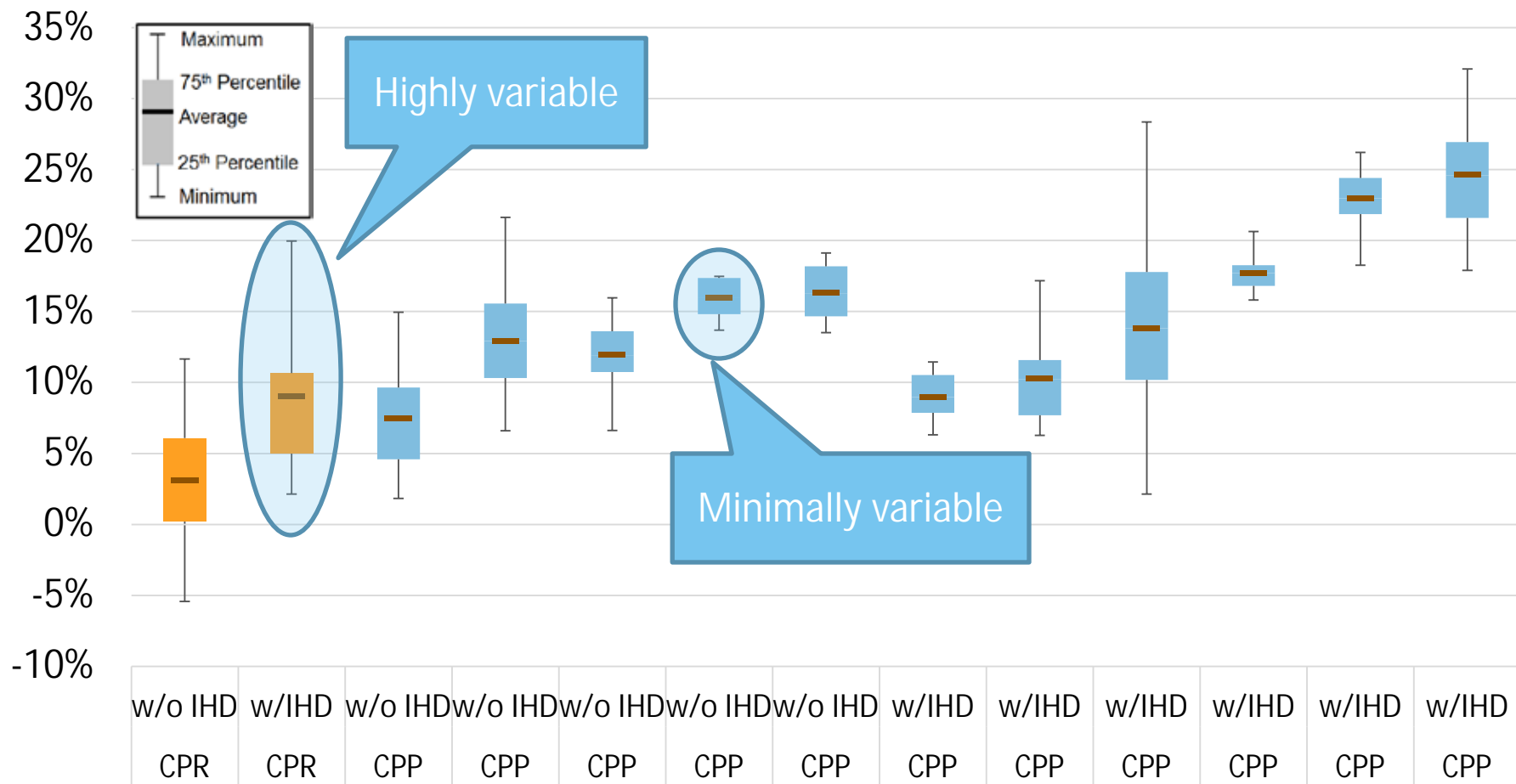


Peak Demand Reductions

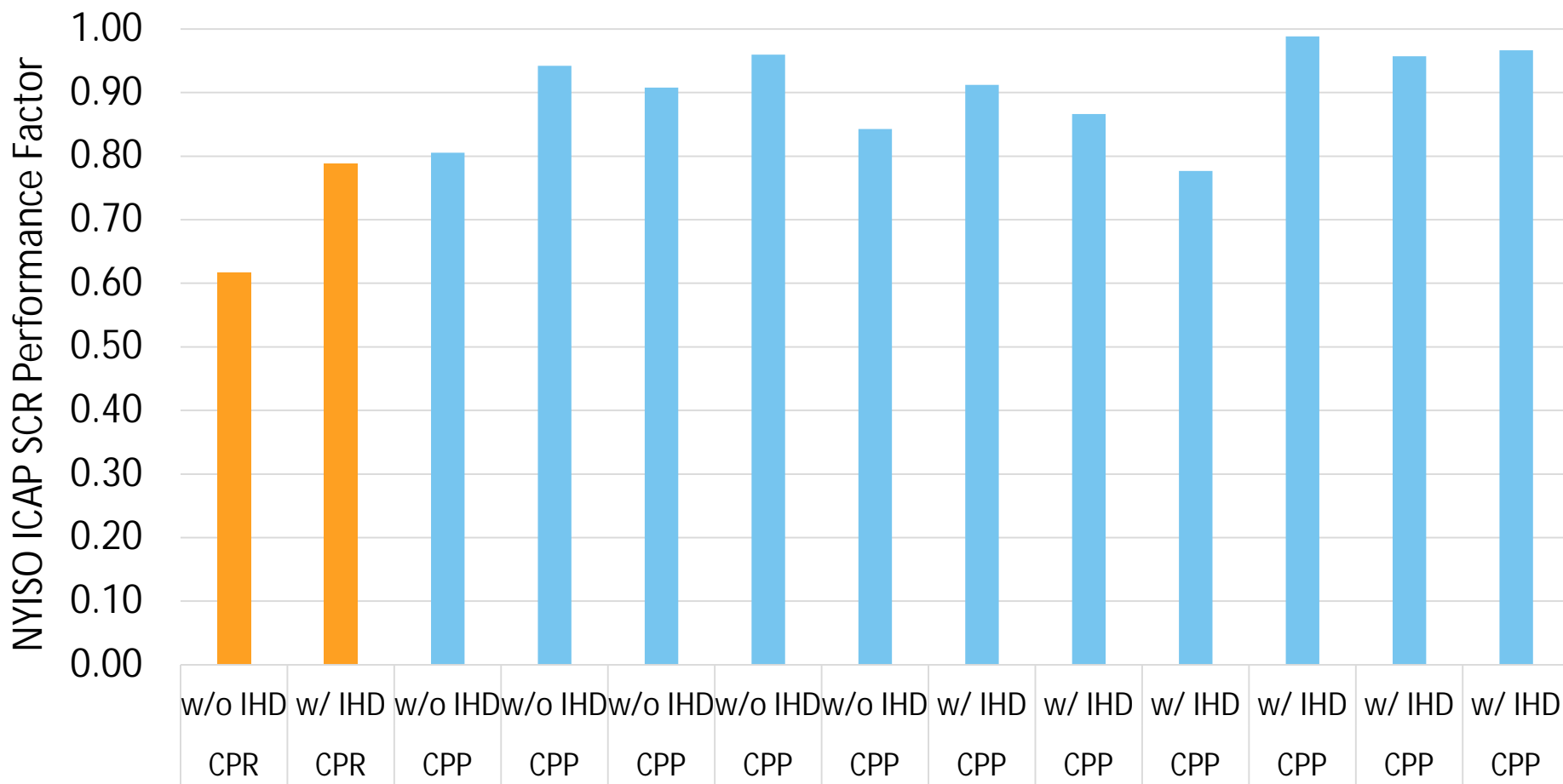
CPP > CPR (All studies)



Variability of Peak Demand Reductions Across Events: CPP > CPR (All studies)



Reliability/Predictability of Peak Demand Reductions: CPP > CPR (All studies)



Info and Control Tech Policy Issues

- IHDs – Proponents claim that it should enable customers to become more engaged and increase capabilities to respond to TBR
- PCTs make it easier for customers to alter their electricity use in response to TBR
- IHD and PCT cost \$\$ to procure, provision, install and maintain
- Utilities must assess if they are cost effective ways to augment load response from TBR



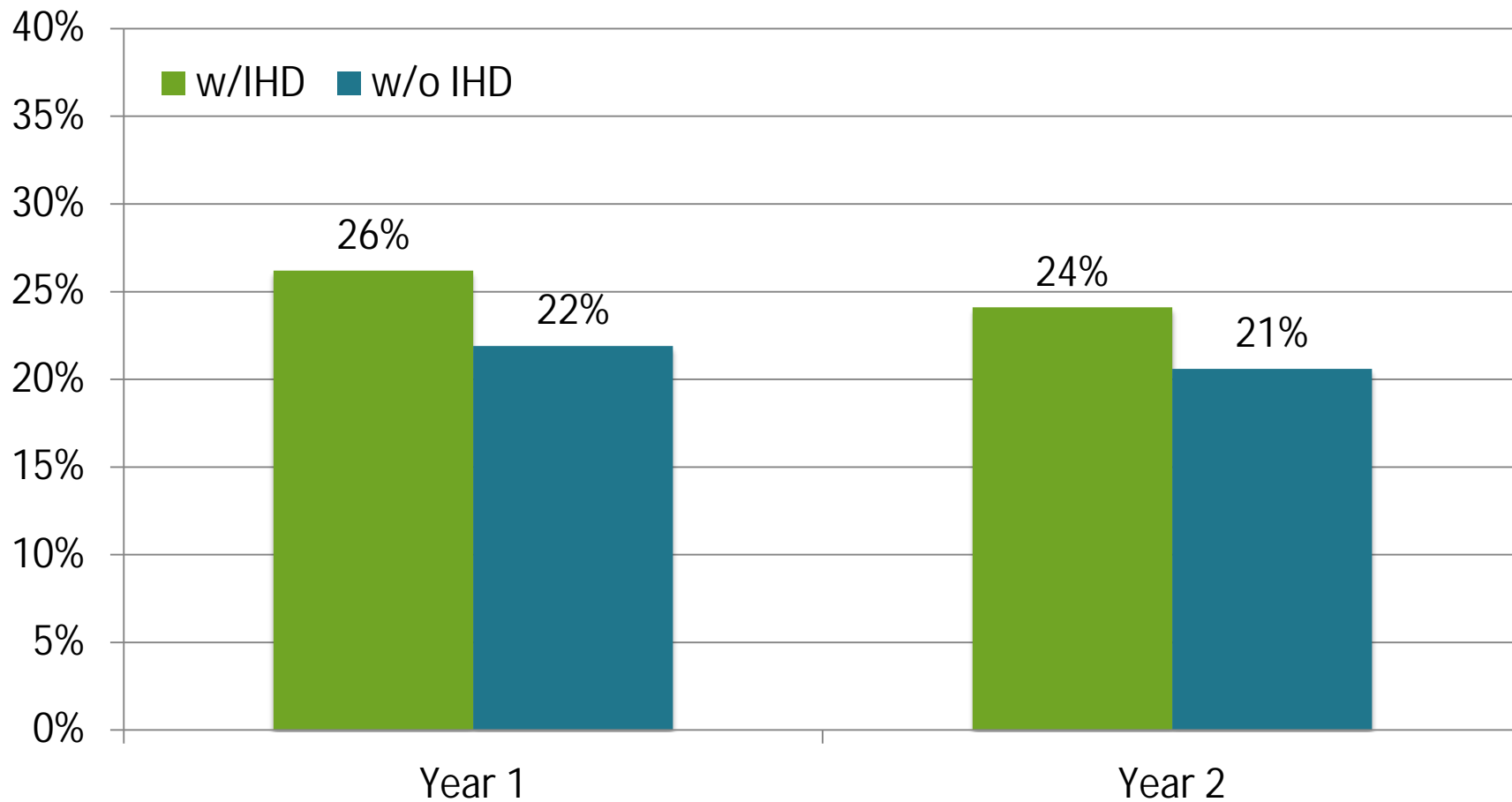
Experiences with IHDs (SMUD)

Treatment Group	% Connected All the Time	% Connected Some of the Time	% Never Connected
Opt-in CPP, IHD Offer	11.6%	27.4%	61.0%
Opt-in TOU, IHD Offer	11.6%	22.8%	65.6%
Default TOU-CPP, IHD Offer	18.8%	39.3%	42.0%
Default CPP, IHD Offer	14.3%	42.9%	42.9%
Default TOU, IHD Offer	18.2%	23.1%	58.7%



Demand Reductions for CPP

w/IHD = w/o IHD (SMUD)

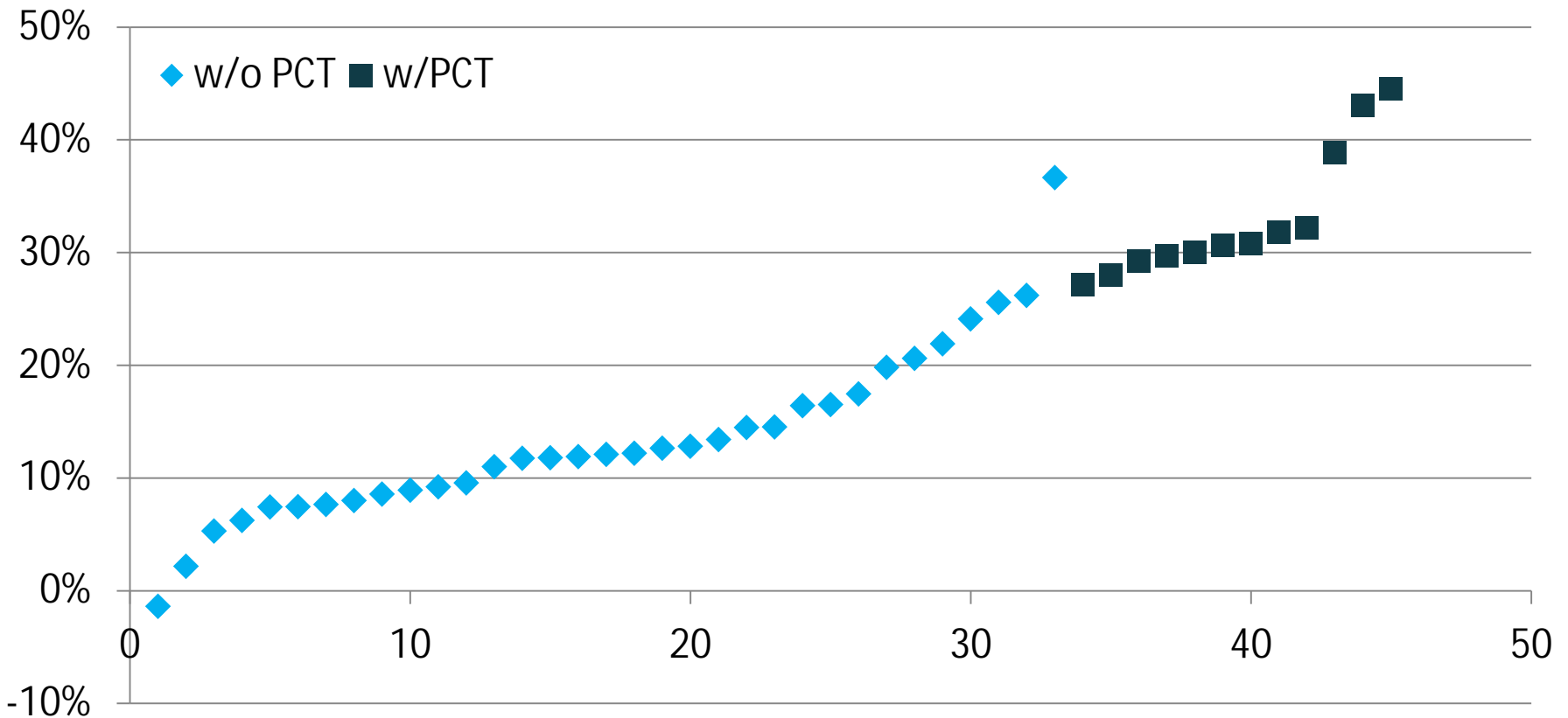


Info Tech Offering Reduces Cost-Effectiveness of TBR (SMUD)

Recruitment Approach	Scenario Offer	Benefit-Cost Ratio
Opt-in	TOU, no IHD	1.19
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	CPP, no IHD	2.05
	CPP, with IHD	1.30



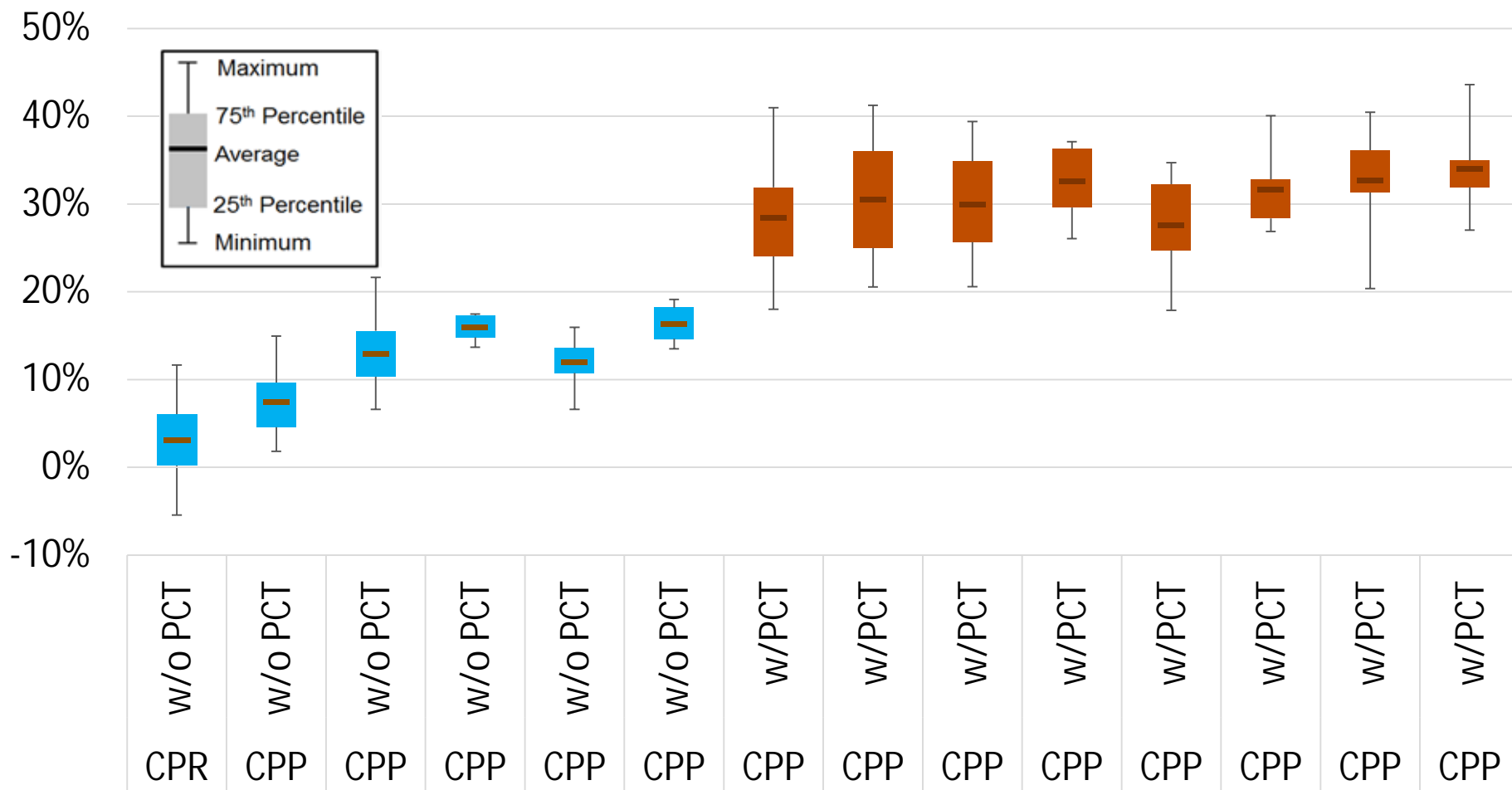
Demand Reduction for CPP & CPR w/PCT > w/o PCT (All studies)



*** All CPP and CPR impacts are portrayed. Each data point represents a treatment-specific impact.**



Variability of Peak Demand Reductions Across Events: w/o PCT > with PCT



Cost Effectiveness of VPP w/ PCTs (OG&E)

Benefit-Cost Ratios

Participant Test	1.50
Rate Impact Measure Test	1.01
Total Resource Cost Test	1.18
Societal Test	1.18
Program Administrator Cost Test	1.11



Systems Integration and Equipment Capabilities Problems

- Many CBS utilities experienced challenges getting MDMS, CIS, OMS and billing systems to work together seamlessly with IHDs & PCTs
 - End-to-end testing and detailed process flows developed during the planning phase of the studies helped many mitigate or remedy issues
- Many vendors oversold and under-delivered products and support services
 - Several utilities avoided these challenges because they dedicated the time and resources during the planning phase to ensure the equipment did what is was supposed to do



Follow-On Actions of CBS Utilities

CEIC	<i>Still determining in Ohio but useful in Pennsylvania AMI proceeding</i>
DTE	<i>~75% of CBS population remained on the rate after the study and working w/ PSC to remove customer cap for broad-based deployment</i>
GMP	<i>Filed with the PSC to offer TOU w/ CPP to residential customers</i>
LE	<i>Redesigned existing TOU rate based on study results</i>
MMLD	<i>Nothing yet</i>
MP	<i>Still in the field</i>
NVE	<i>30-40% of CBS population remained on the rate after the study and working w/ PSC to enable broader roll-out</i>
OG&E	<i>Recruited ~18% of entire residential class so far to take up VPP</i>
SMUD	<i>Plan to offer TOU as default rate starting in 2018</i>
VEC	<i>Nothing yet but may help inform response to recent legislation</i>



“Deep-dive” Evaluation of Targeted Policy Issues Reports

Topics	Publication Dates
Utility engagement of consumers: Best practices and lessons Learned	Q4 2014
Identifying customer biases toward opt-out (default) approaches to enrollments in time-based rate programs	Q2 2015
Effects of time-based rates on vulnerable customer groups (e.g., low income and the elderly).	Q4 2015
Spillover benefits from time-based rates and inter-temporal demand impacts.	Q4 2015
Relative merits of alternative experimental designs for studies and evaluations of time-based rates.	Q1 2016



Questions/Comments

Charles Goldman

(510) 486-4637

CAGoldman@lbl.gov

Peter Cappers

(315) 637-0513

pacappers@lbl.gov



Appendix – Additional and Supporting Material



Status of Evaluation Reports

CBS Utilities	Initial	Final
CEIC	<u>Q2 2013</u>	<i>Q2 2015</i>
DTE	<u>Q1 2014</u>	<u>Q4 2014</u>
GMP	<u>Q4 2013</u>	<u>Q2 2015</u>
LE	<u>Q2 2015</u>	Q3 2015
MMLD	<u>Q2 2012</u>	<u>Q3 2013</u>
MP	<u>Q1 2014</u>	Q1 2016
NVE	Q2 2015	Q1 2016
OG&E	<u>Q2 2011</u>	<u>Q3 2012</u>
SMUD	<u>Q4 2013</u>	<u>Q4 2014</u>
VEC	<u>Q4 2013</u>	<i>Q2 2015</i>

Legend

DOE Approved

Awaiting Approval

Draft

Anticipated



Recruitment Approach Doesn't Dramatically Affect Attitudes About TBR by the End

- Opt-out participant attitudes to time-based rates were indifferent to positive but not negative

How satisfied are you with your current electricity pricing plan?

I want to stay on my pricing plan

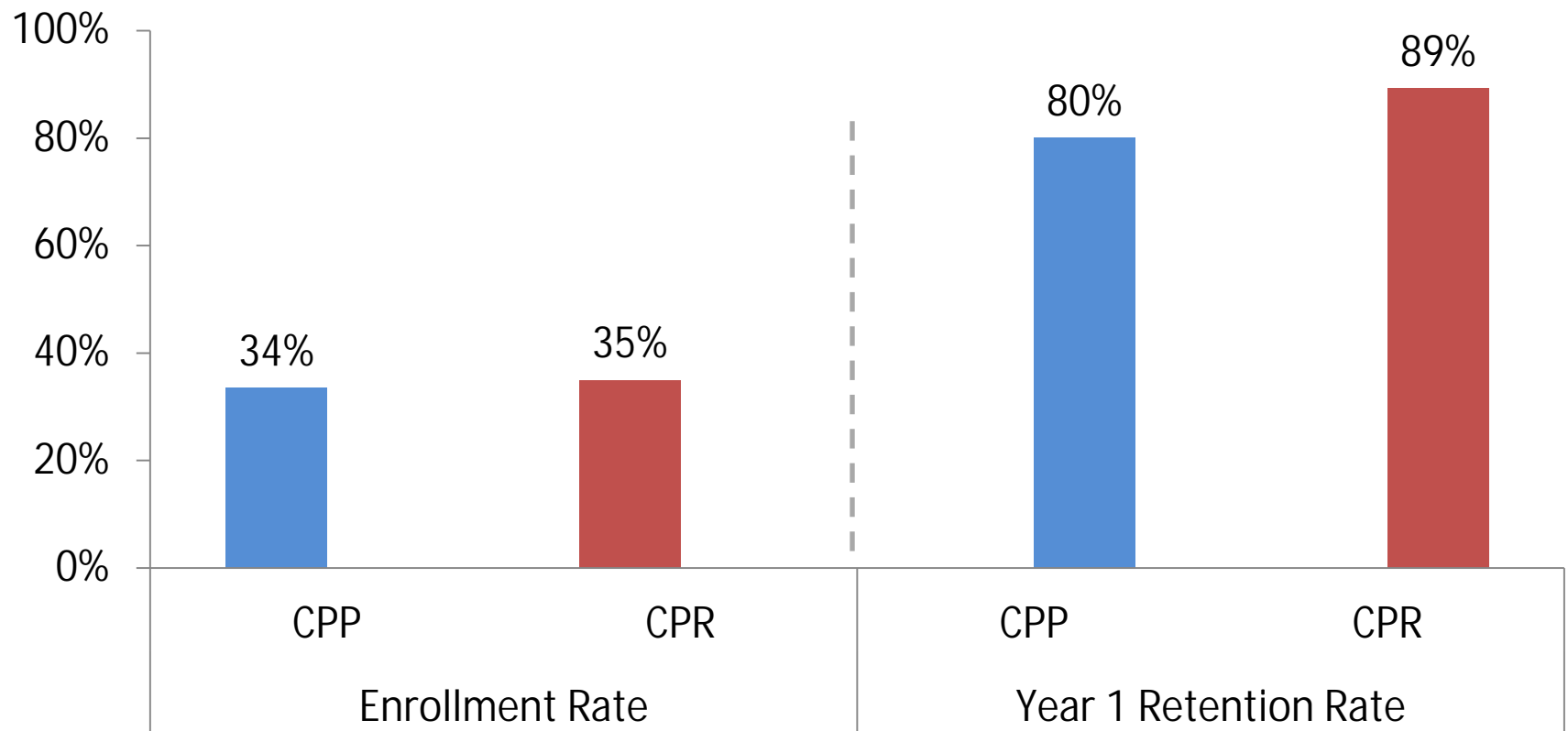
	Opt-in CPP	Opt-out CPP	t-stat
Very satisfied	0.302 (0.019)	0.317 (0.034)	-0.376
Somewhat satisfied	0.588 (0.021)	0.568 (0.037)	0.476
Somewhat dissatisfied	0.095 (0.012)	0.093 (0.021)	0.101
Very dissatisfied	0.014 (0.005)	0.022 (0.011)	-0.649
Number of respondents	566	183	

	Opt-in CPP	Opt-out CPP	t-stat
Strongly agree	0.498 (0.022)	0.301 (0.036)	4.687
Somewhat agree	0.264 (0.019)	0.294 (0.036)	-0.761
No opinion	0.192 (0.017)	0.344 (0.037)	-3.697
Somewhat disagree	0.029 (0.007)	0.031 (0.014)	-0.104
Strongly disagree	0.017 (0.006)	0.031 (0.014)	-0.901
Number of respondents	516	163	



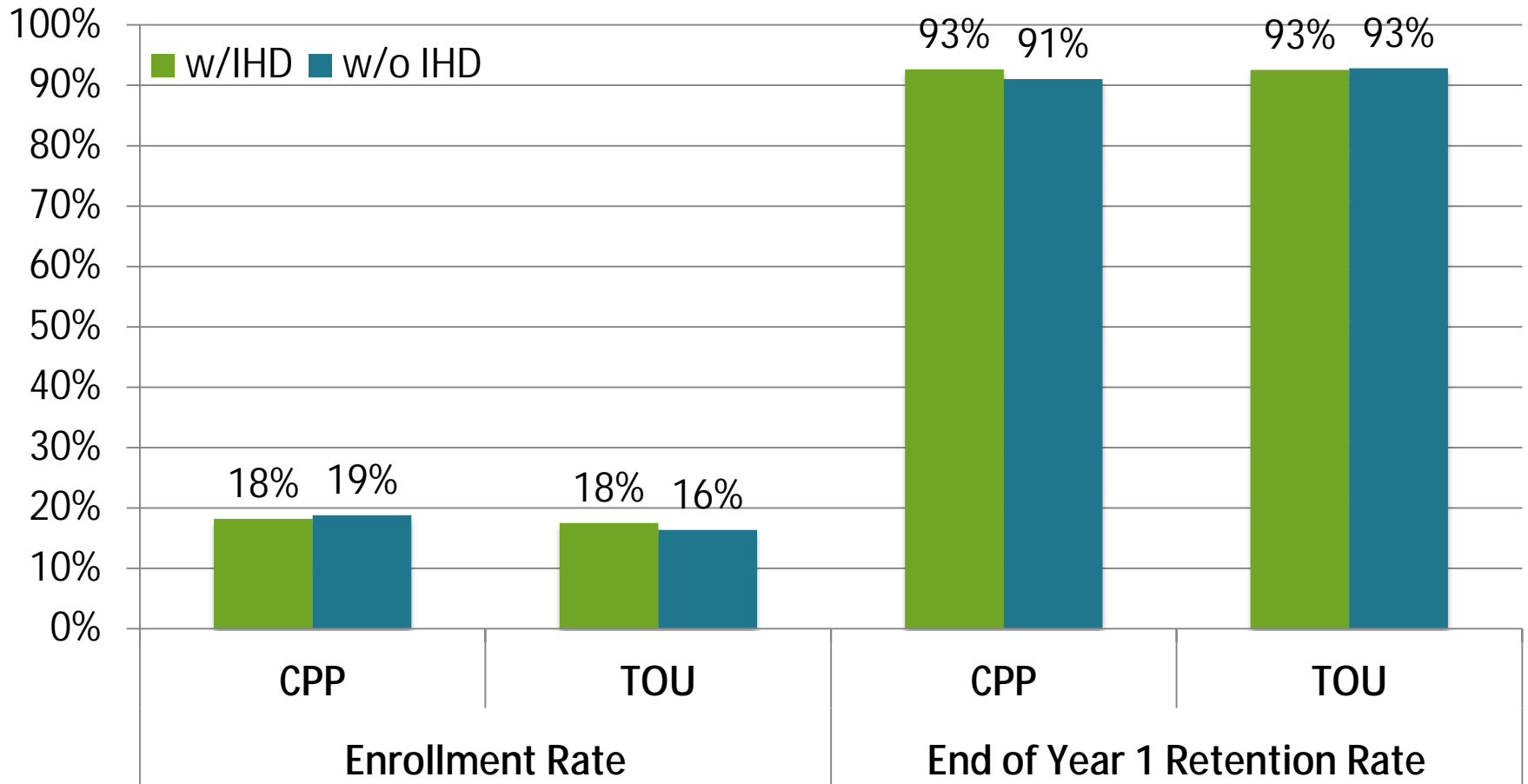
Enrollment & Retention Rates

CPR \geq CPP (GMP)



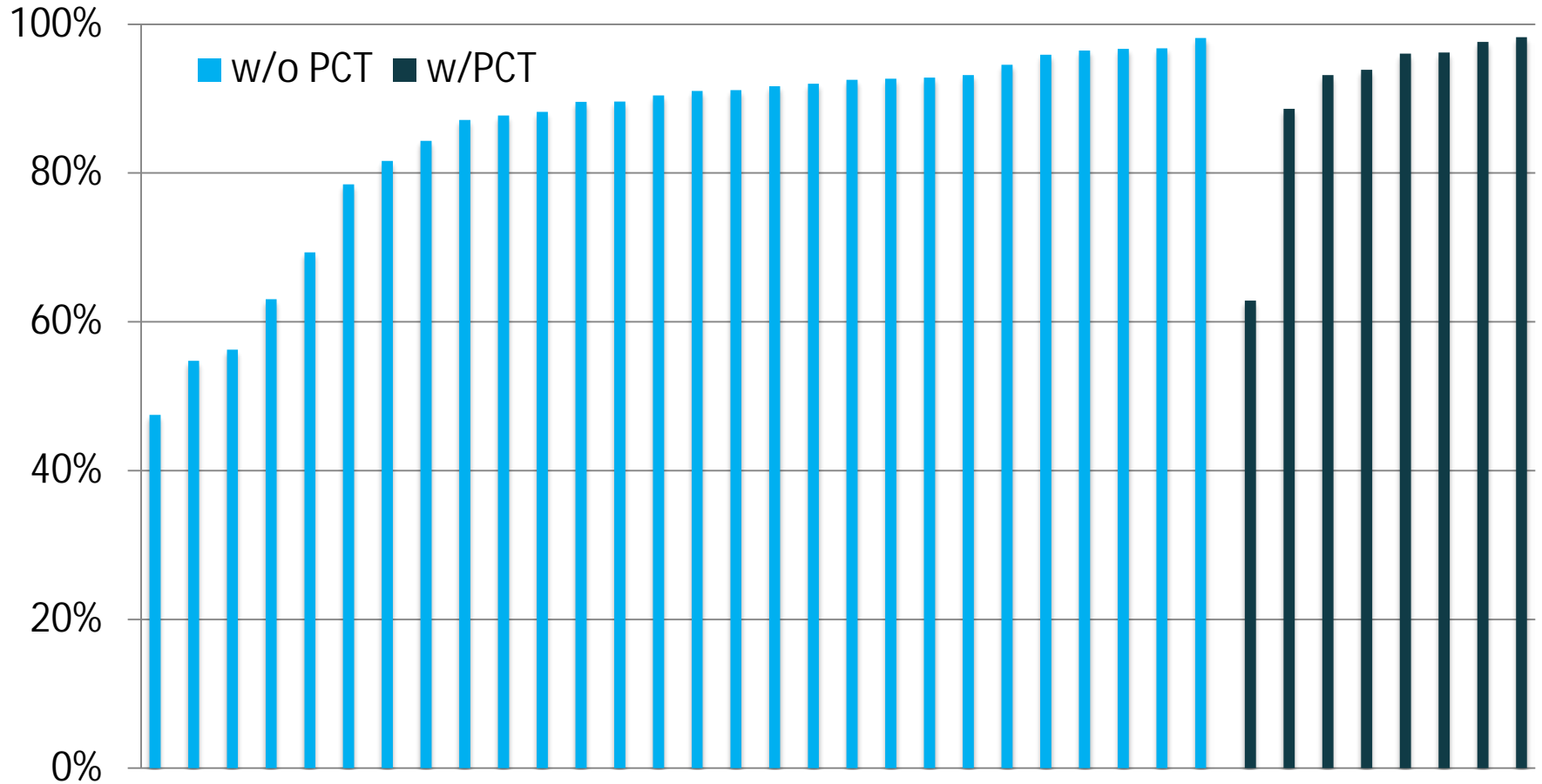
Enrollment & Retention Rates

w/IHD = w/o IHD (SMUD)

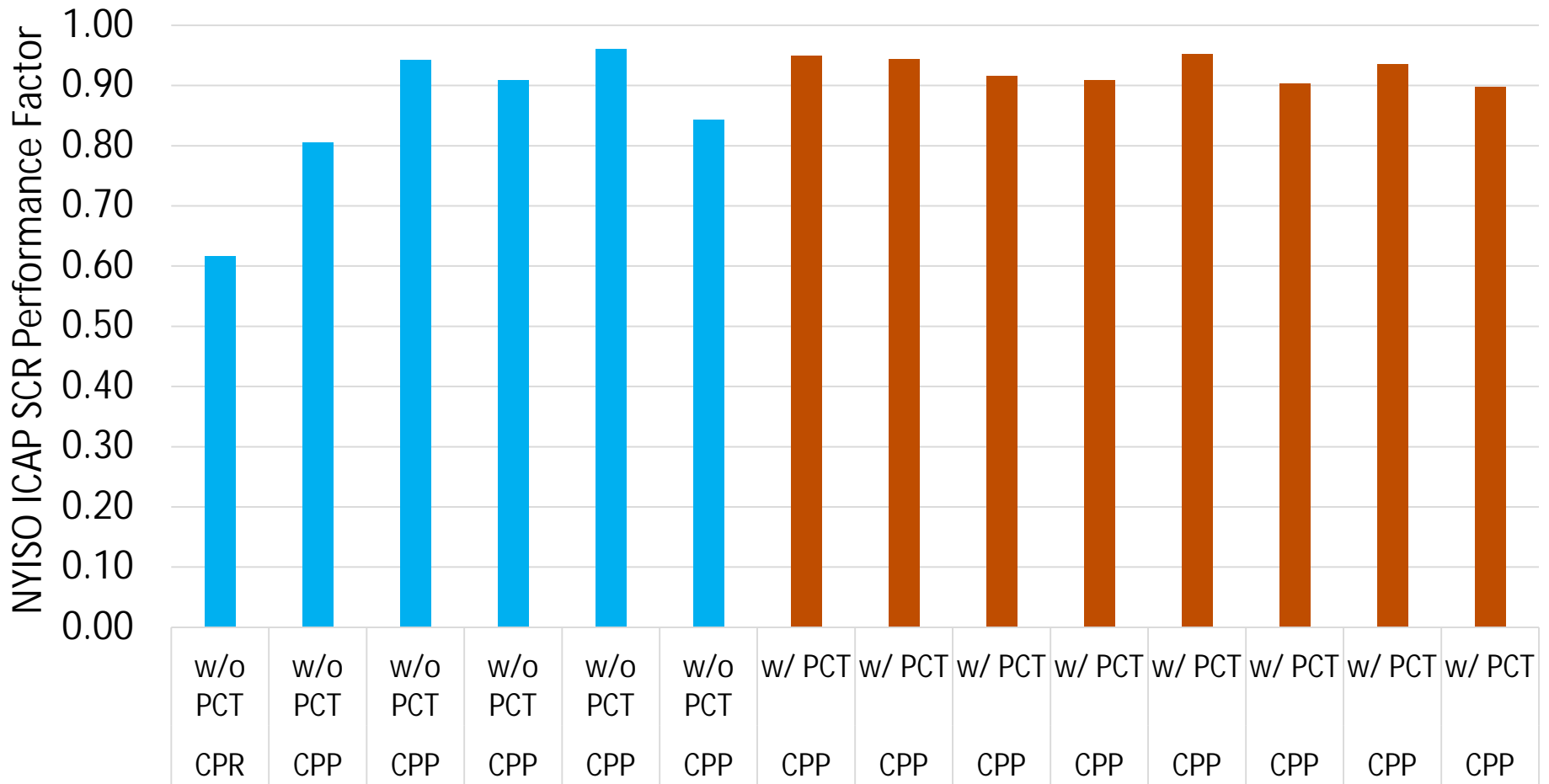


Retention Rates

w/PCTs = w/o PCTs (All studies)



Reliability/Predictability of Peak Demand Reductions: w/PCT > w/o PCT (All studies)



Two Types of Analysis

- **CBS Program Impacts**
 - Use the findings in the CBS projects' evaluation reports to provide a summary of results across all CBS utility projects
- **“Deep-dive” Evaluation of Targeted Policy Issues**
 - Perform an independent analysis of the CBS projects' raw data to address specific policy issues of important to industry



CBS Program Impact Reports

- An assessment of (to the extent findings are included in the CBS Projects' evaluation reports):
 - Customer acceptance and attrition
 - Customer load impacts
 - Utility cost effectiveness
- **Timing of Reports**
 - Interim: Q2 2015 (Released by end of May)
 - Final: Q1 2016



1. The Effects of Time-Based Rates on Vulnerable Populations (2)

- This quantitative analysis seeks to address the following set of issues:
 - Is there any difference in load response between vulnerable populations, to the extent that they appear in these pilots, in relation to their counterparts?;
 - How are the bills of vulnerable populations impacted relative to those in other populations?;
 - Do customers in vulnerable populations enroll and drop out at a different frequency or at different times than other customers?; and
 - Do customers in vulnerable populations accept technology at different rates than their counterparts?



2. The Spillover Benefits From Time-Based Rates: Intertemporal Load Impacts

- There is a prevailing assumption based on economic theory that customers exclusively respond to a time-based rate when the price changes.
 - E.g., Customers on a critical peak pricing rate are presumed to not alter their electricity consumption on non-event days
- However, these rates may have additional spillover benefits.
 - If customers form peak-reduction habits (e.g., washing clothing at night), then the rates could cause loads to shift even in the absence of a price change.



2. The Spillover Benefits From Time-Based Rates: Intertemporal Load Impacts

- If these spillover effects are not properly accounted for, they may have detrimental implications for load forecasting, baseline creation, and event dispatch planning activities
- This quantitative analysis will seek to understand if, and the degree to which, customers alter the consumption of electricity in time periods unanticipated based on the rate they are on



3. Experimental Design as the Gold Standard

- RCTs are seen academically as the "gold-standard" of program design and evaluation
- Properly designing and successfully implementing an RCT is costly from a time, human capital and financial resource perspective
- Little is know about the trade-off between RCTs versus quasi-experimental approaches
 - How much harder are RCTs to implement?
 - How much more accurate and precise are the results?



3. Experimental Design as the Gold Standard

- The SGIG CBS effort allows one to test the validity of RCTs versus quasi-experimental approaches
- Gaining an understanding of how biased and correlated load impact results are when derived from experiments vs. quasi-experimental methods (including commonly applied baseline methods for CPR) will:
 - Help policymakers and utilities understand the tradeoffs associated with employing these different evaluation approaches; and
 - Help this and related fields within the electric industry develop better and more accurate baseline methodologies for residential customers



4. Utility Engagement of Consumers: Best Practices and Lessons Learned

- Throughout the later part of the 20th century, the electric industry rarely attempted to engage residential customers
- The introduction of AMI and the plethora of customer-side-of-the-meter technology and service opportunities that such investments enable puts utilities in a new position where they have to engage residential customers to realize claimed benefits as part of the AMI business case



4. Utility Engagement of Consumers: Best Practices and Lessons Learned

- The CBS projects all had to engage residential customers in order to fill their studies with the necessary sample sizes
- Conveying the initial acceptance rates, the evolution of retention rates, as well as the lessons CBS utilities learned along the way for how to engage customers would be valuable to convey to the industry in a qualitative manner



5. Evidence and Exploration of Consumer Bias towards Default TBR

- Economists and psychologists have long recognized a behavioral phenomenon called the default bias:
 - When facing a choice with a default option, people are predisposed to accept the default
- Documenting this phenomenon has been very influential because it provides a non-intrusive way to guide behavior without constraining individual choice
- Although default bias has been well documented in a variety of contexts (including organ donation, retirement savings, and health insurance), it is not well understood



5. Evidence and Exploration of Consumer Bias towards Default TBR (2)

- An improved understanding in the electricity sector of why customers' rate participation choices are affected by the default choice can refine the design of future default options
 - "Nudge" consumers into the "right" choice for them
- This quantitative analysis will help make future time-based rate roll-outs more effective and their transition more successful.

