Lighting in a Bottle: Exploring Residential Lighting Markets

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2015 IEPEC Conference — Long Beach, California

What's the Point (of Sale)?

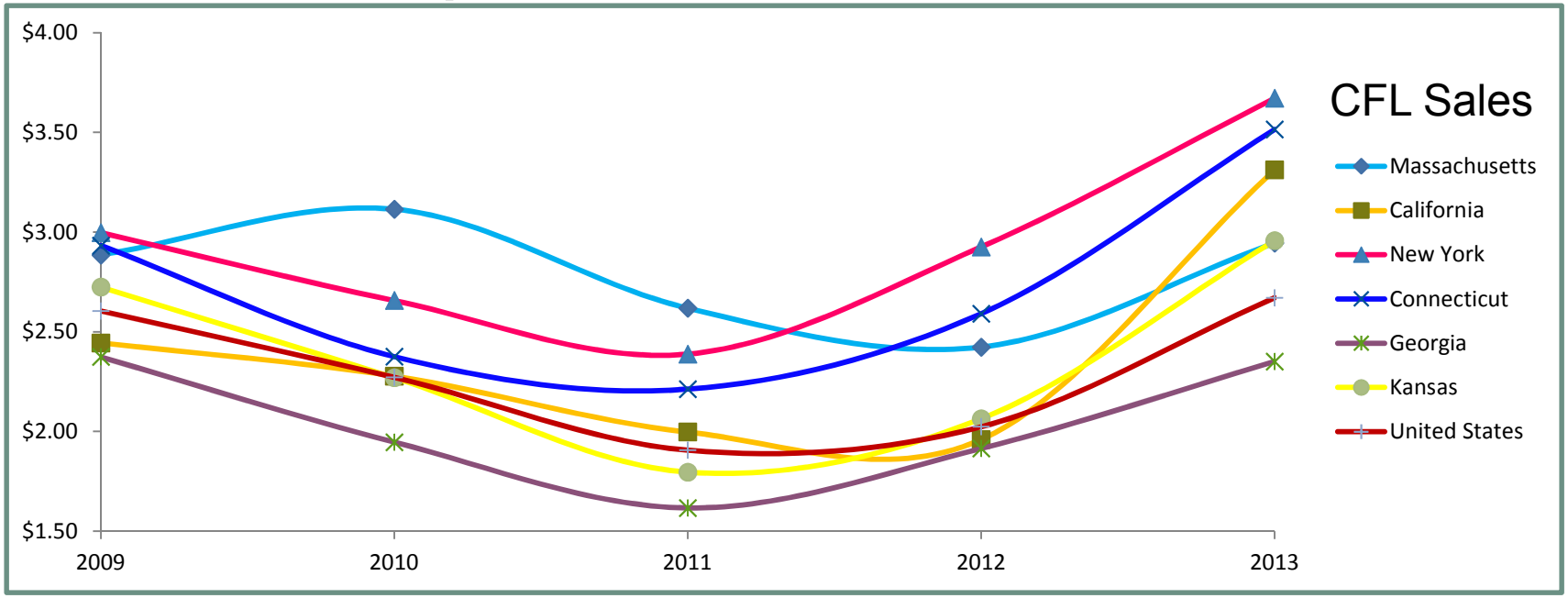
Program Activity Impacts Efficient Bulb Sales – Proof Across 44 States and Five Years

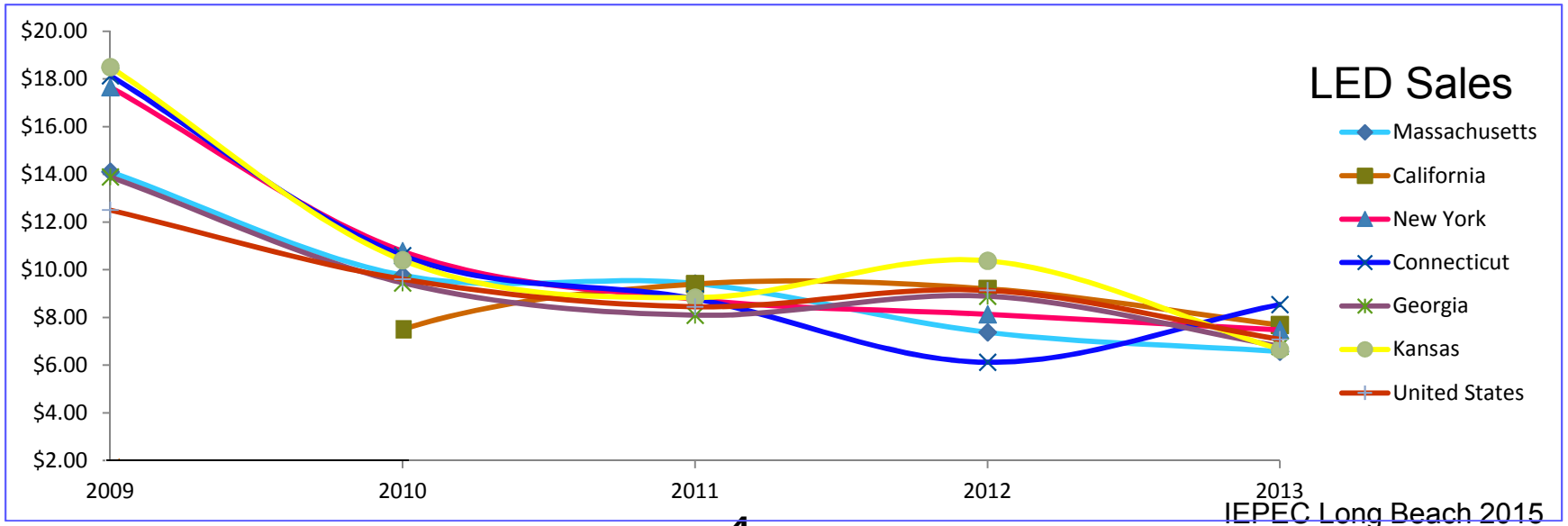
NMR Group, Inc.

POS Model: Research Goals

- Provide evidence on whether or not programs still impact EE bulb sales since EISA.
- Descriptive EE bulb program versus non-program pricing trends were unexpected and suspect.

Price per bulb: 2009-2013

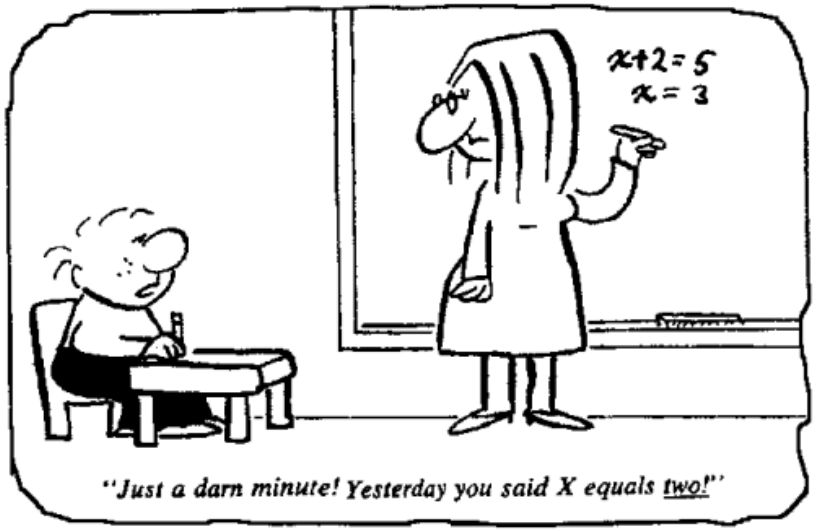




POS Model: Model and Results

$$\log(\%efficient.sales_{i,j}) = \alpha + \beta_{0,i} + \beta_1 \log(cr.sqft_{i,j}) + \beta_2 \log(noncreed.sqft_{i,j}) + \beta_3 avg.electric.price_{i,j} + \beta_4 cost.of.living_i + \sum_{k=1}^{p} \gamma_k dem.var_{i,j,k} + \boldsymbol{\theta prog2_{i,j}} + \tau_j + \epsilon_{i,j}$$

- POS data was used to identify count of EE bulbs sold.
- Program was defined as the budget spent on residential lighting programs.
- A $1M increase in budget is associated with:
  - 0.25% increase in all EE bulb sales
  - 0.25% increase in CFL sales
  - 0.49% increase in LED sales



POS Model: Takeaways

- Simplistic descriptive approaches to understanding the lighting market fall short.
- Halogen and LED sales are increasing while CFL and Incandescent are decreasing.
- Programs continue to have an influence on EE bulb sales with a higher rate of possible return for LEDs.
  - EE bulbs in program states have lower incremental cost compared to non-program states.

WE KNOW WHAT YOU DID LAST SUMMER

IEPEC International Energy Program Evaluation Conference

NMR Group, Inc.

IEPEC 2015
August 13, 2015

David Barclay
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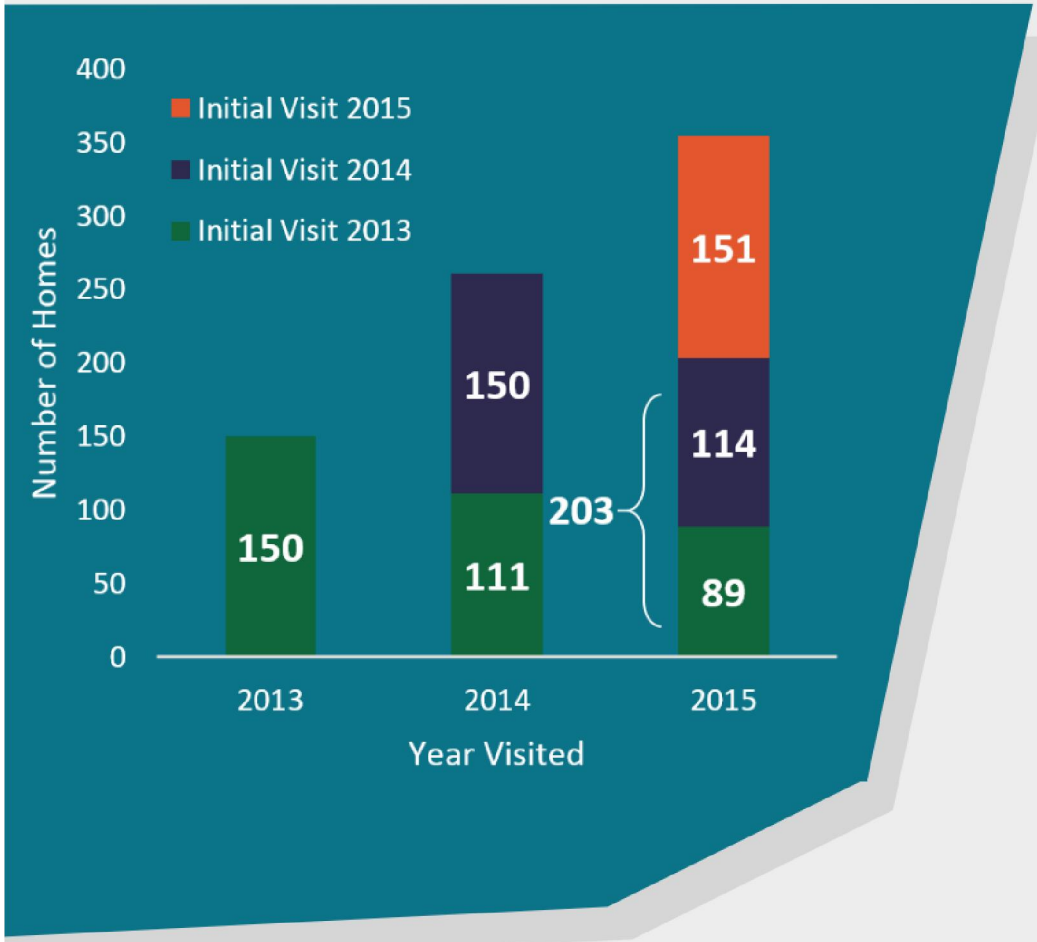
Lisa Wilson-Wright
Matt Nelson

Revelations of a Lighting Panel Study

www.nmrgroupinc.com

BACKGROUND



Multi-Year Panel Study

Track Lighting Changes

Observe Behavior

Increase Understanding

Inform Programs

LEGEND

Bulb Types

Compact Fluorescent (CFL)

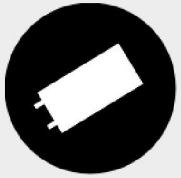
Empty Socket

Incandescent

Light Emitting Diode (LED)

Other Bulbs

Halogen



Linear Fluorescent

Bulb Sources

Purchased

Stored

Fixture

WHAT HAPPENED?

Replaced Bulbs (Original)

66% 25% 1% 2% 1% 4% 1%

Replacement Bulbs

25% 49% 17% 2% 1% 6% <1%

Dramatic Shift

2 in 3

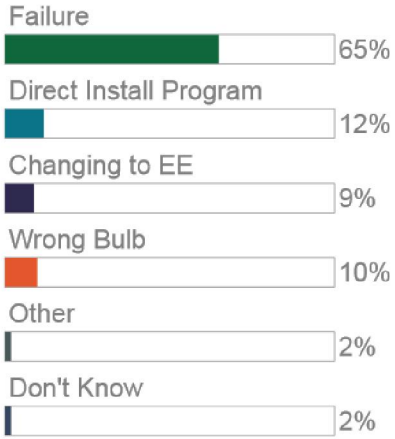
Halogen, linear fluorescent, and other less common bulb types unchanged.

Panelists maintain a fair number of empty sockets but not the same ones!

Based on 1,522 observed changes between 2013 and 2015

DRIVERS AND SOURCES

Replacement Drivers



Sources of Replacement Bulbs

72% 26% 2%

Three times more likely to purchase a new bulb

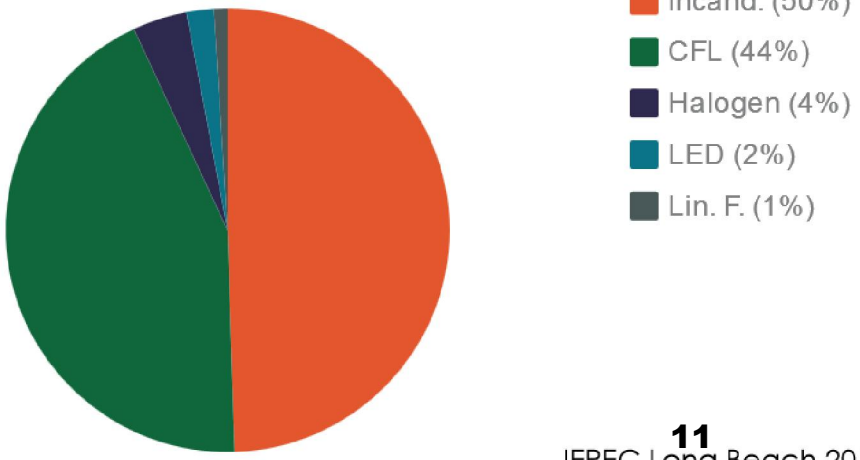
Stored Bulbs Quick Facts

15.6 Average number of bulbs in storage

64% Percent of stored bulbs are Incadescent

9% Percent of stored bulbs were installed 2013 - 2015

Bulbs Installed from Storage



BIAS AND STUDY EFFECTS

The response rate for panel visits was very high and there appears to be no or little non-response bias or reactive effects among panelists.

Steps Taken to Reduce Non-response Bias

High Response Rate	20%+
High Take Rate	50%+
High Panel Retention	74%+

Oversample multifamily to ensure representation

Data weighted to demographics of Massachusetts

Analysis show no significant demographic differences between Wave 1 & 2 Panelists or New Visits

Few or No Reactive Effects

Sample designed to test for reactive or Hawthorne effects

Results compared across waves and with new households

Similar or identical levels of penetration, saturation, and purchase behavior

Panelist participation in EE programs similar to population

More Bulb for the Buck?

Verifying Ratepayer Value in an Upstream Lighting Program

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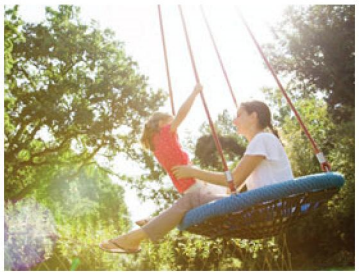
Eric Rambo, Ph.D., Cadmus
Bryan Ward



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Background

- **What?** In-store residential upstream lighting program verification and pricing study
- **Who?** 24 stores across five retailers in neighboring Program and Non-Program States
- **When?** May 2014, building on four previous lighting studies conducted 2012-2014

Why? Research Questions

Are discounted lamps priced according to the contract?

Do program buydowns explain all impacts on prices?

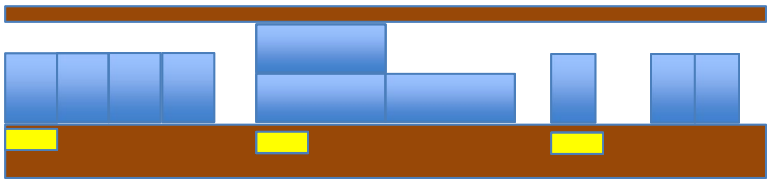
Field Work and Analysis

- Visited a matched sample of 12 stores in a Program State and 12 in a Non-Program State
- Recorded price and lamp characteristics

SKUs Matched Between Store Sets	Program State SKUs	Non-Program State SKUs
Program and Program-Equivalent	330	393
Non-Program and Non-Program-Equivalent	782	759

- Reviewed utility-retailer memoranda of understanding (MOUs):
  - Base, undiscounted lamp SKU price by retailer and model
  - Incentive or "buydown" amount by which to reduce lamp SKU price
  - Discounted lamp SKU price expected on the shelf
- Analyzed price at the SKU level for the same lamps, sold by the same retailers in both states

Some Terminology: IOPP



Observed Shelf Price

+

Contract Incentive

Implied Original Pack Price = IOPP

Lamp Types	Category	Program State Price Metric		Non-Program State Price Metric
Program Lamps and Equivalents	Price Equality	IOPP	=	Shelf Price
	Higher Program State IOPP	IOPP	>	Shelf Price
	Lower Program State IOPP	IOPP	<	Shelf Price
Non-Program Lamps and Equivalents	Price Equality	Shelf Price	=	Shelf Price
	Higher Program State Price	Shelf Price	>	Shelf Price
	Lower Program State Price	Shelf Price	<	Shelf Price

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Overview of Findings

- Net Pack Price Effect is the average price difference between Program State and Non-Program State prices for the same lamp SKUs
  - Negative NPPE → lower Program State price
  - Positive NPPE → higher Program State price

$$Net\ Pack\ Price\ Effect = (\%\ Higher\ Program\ State\ IOPP \times Average\ Price\ Difference\ where\ Higher) + (\%\ Lower\ Program\ State\ IOPP \times Average\ Price\ Difference\ where\ Lower)$$

Retailer	Program Lamp SKUs		Non-Program Lamp SKUs	
	Program State SKUs with Non-Program State Match(es)	Net Pack Price Effect	Program State SKUs with Non-Program State Match(es)	Net Pack Price Effect
Retailer 1	106	$0.41	169	$(0.09)
Retailer 2	15	$0.46	2	$0.00
Retailer 3	9	$0.18	6	$(0.83)
Retailer 4	169	$0.46	237	$0.07
Retailer 5	31	$0.78	368	< $(0.01)

Considerations and Further Work

- We expected the base prices on the MOUs to equal the prices in the non-Program State; however, MOU base prices were frequently higher
- Findings do not appear to result from problems with application of discounts in-store
- Potential drivers include:
  - Short-term promotions affecting the Non-Program State to a greater extent than the Program State
  - Interstate spillover
  - Outdated base price data in MOUs
- Areas for further research
  - Potential follow-up study in 2016
  - Potential for studies in other jurisdictions

Prices of Bulbs

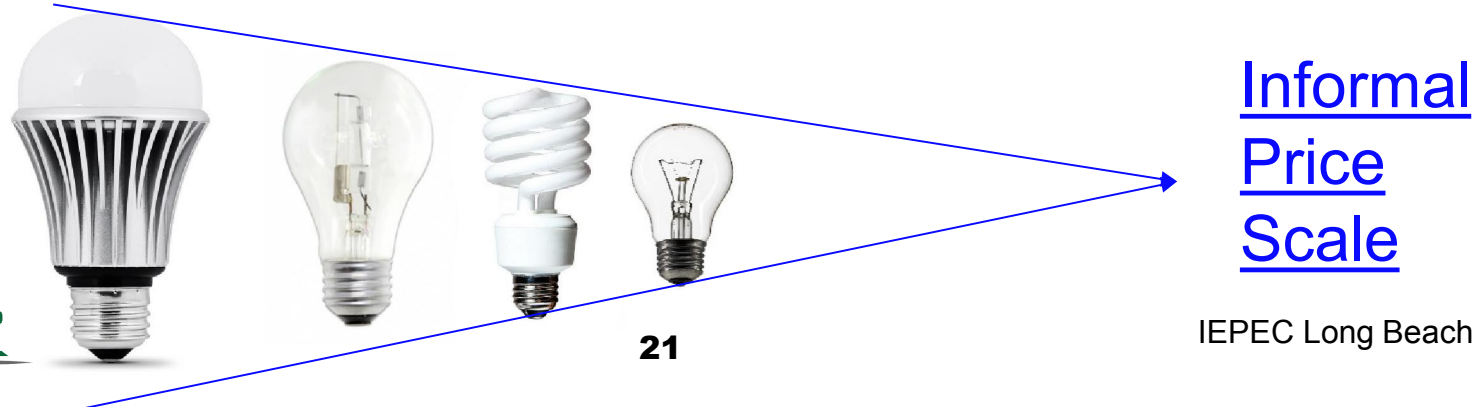
What do the POS data and the data on Program and Non-Program activity tell us about bulb Pricing?

POS: Price of bulbs-Comparing average price does not lead to a clear picture of program influence.

Year	Average price of LED		Average price of CFL		Average price of Halogen		Average price of Incandescent	
	Program	Non-program	Program	Non-Program	Program	Non-program	Program	Non-program
2009	$12.29	$13.58	$2.63	$2.46	$4.73	$4.53	$0.90	$0.76
2010	$9.64	$9.37	$2.33	$1.92	$4.94	$4.70	$0.87	$0.69
2011	$8.45	$8.37	$1.94	$1.63	$4.84	$4.62	$0.83	$0.70
2012	$9.07	$9.72	$2.04	$1.87	$4.58	$4.58	$0.88	$0.77
2013	$7.12	$6.71	$2.69	$2.48	$3.75	$3.74	$0.99	$0.86

POS: Price of bulbs-The incremental cost of EE bulbs in program states are usually lower.

	LED Incremental Cost						CFL Incremental Cost					
	CFL		Halogen		Incandescent		LED		Halogen		Incandescent	
Year	Program	Non-Program	Program	Non-Program	Program	Non-Program	Program	Non-Program	Program	Non-Program	Program	Non-Program
2009	$9.66	$11.12	$7.56	$9.05	$11.39	$12.82	-$9.66	-$11.12	-$2.09	-$2.07	$1.73	$1.70
2010	$7.31	$7.45	$4.70	$4.67	$8.78	$8.68	-$7.31	-$7.45	-$2.61	-$2.78	$1.46	$1.23
2011	$6.52	$6.74	$3.61	$3.75	$7.63	$7.68	-$6.52	-$6.74	-$2.91	-$2.99	$1.11	$0.94
2012	$7.03	$7.85	$4.49	$5.14	$8.19	$8.95	-$7.03	-$7.85	-$2.54	-$2.71	$1.16	$1.10
2013	$4.43	$4.23	$3.37	$2.98	$6.12	$5.85	-$4.43	-$4.23	-$1.06	-$1.25	$1.70	$1.63



Informal Price Scale

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Price Sources and Comparisons

Null hypothesis: equality within each row

Research Question	Sources				
	MOU		Program State Observations		Non-Program State Observations
Program and Program-Equivalent Lamps					
Are discounts being applied as expected?	Discounted Price	=	Shelf Price		n/a
Are price impacts fully explained by the program?	Base Price	=	IOPP	=	Shelf Price
Non-Program and Non-Program-Equivalent Lamps					
Are there non-program effects to control for?	n/a		Shelf Price	=	Shelf Price

Question 1:

Are discounts being applied as expected?

Observed lamp prices generally matched—or were lower than—program contracts

Retailer	Program SKUs in the Program State		Average Difference from Contract Base Pack Price
	Count	IOPP Higher than Contract Base-Price	
Retailer 1	106	10 (9%)	$(0.08)
Retailer 2	15	1 (7%)	$(0.15)
Retailer 3	9	0 (0%)	$(0.68)
Retailer 4	169	11 (7%)	$(0.44)
Retailer 5	31	0 (0%)	< $(0.01)

The price is right…

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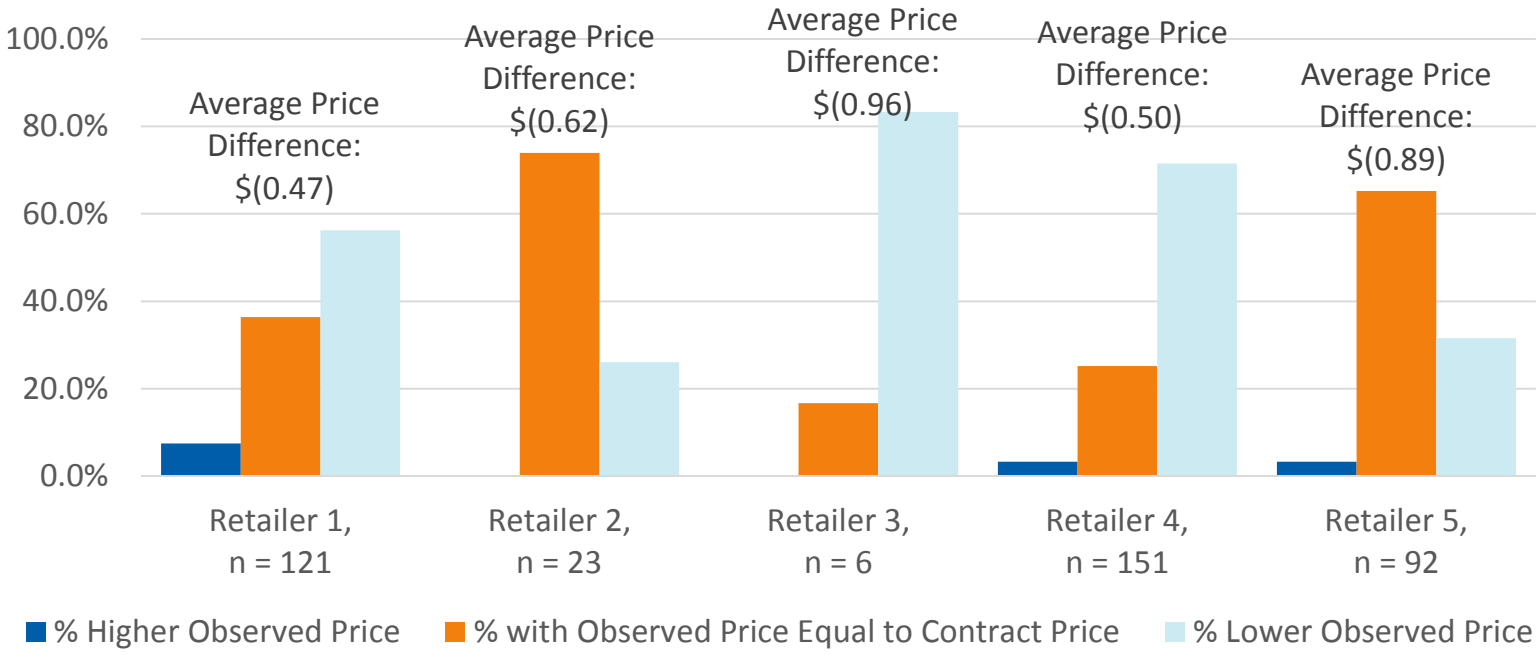
Question 2:

Are price impacts fully explained by the program?

…but where is the price coming from?

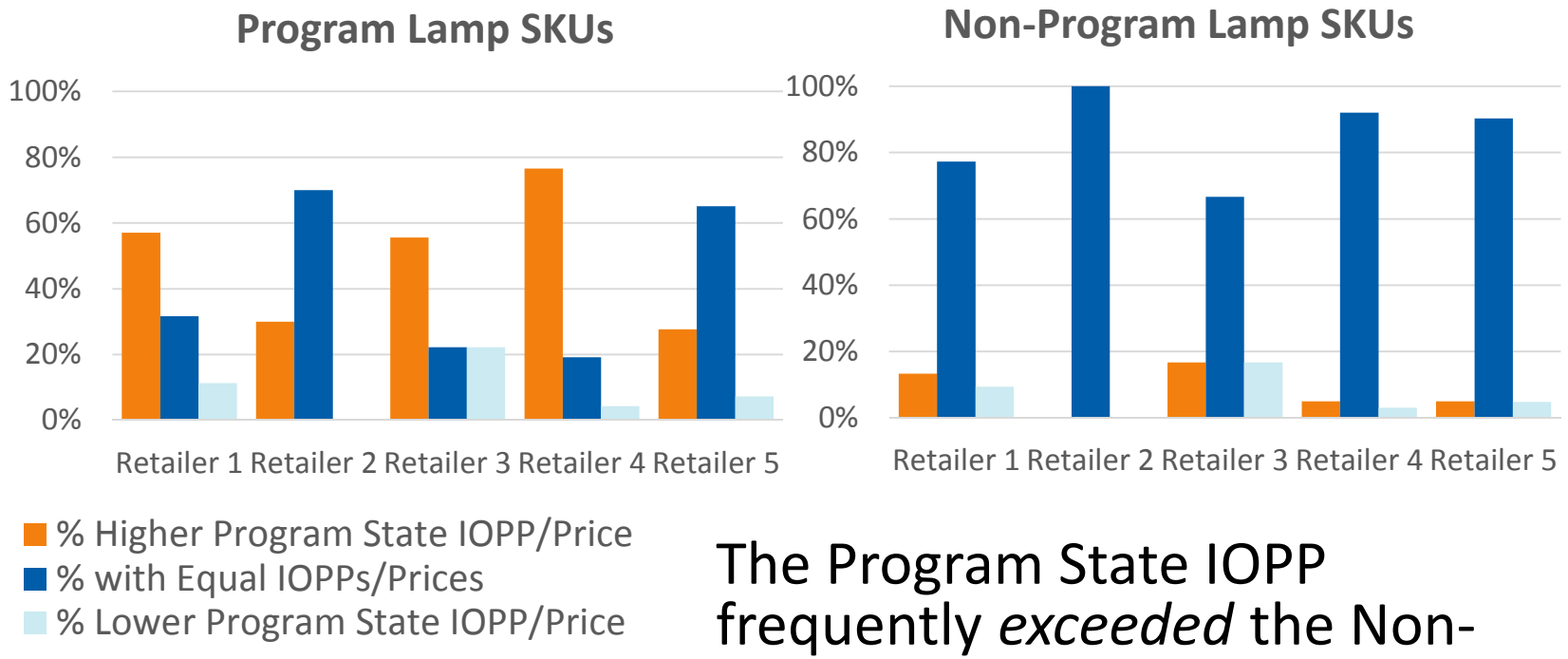


MOU base price frequently *exceeded* the Non-Program State program pack prices

Question 3:

Are there non-program effects to control for?

Could *all* lamp prices in the Non-Program State be lower?



The Program State IOPP frequently *exceeded* the Non-Program State program lamp prices

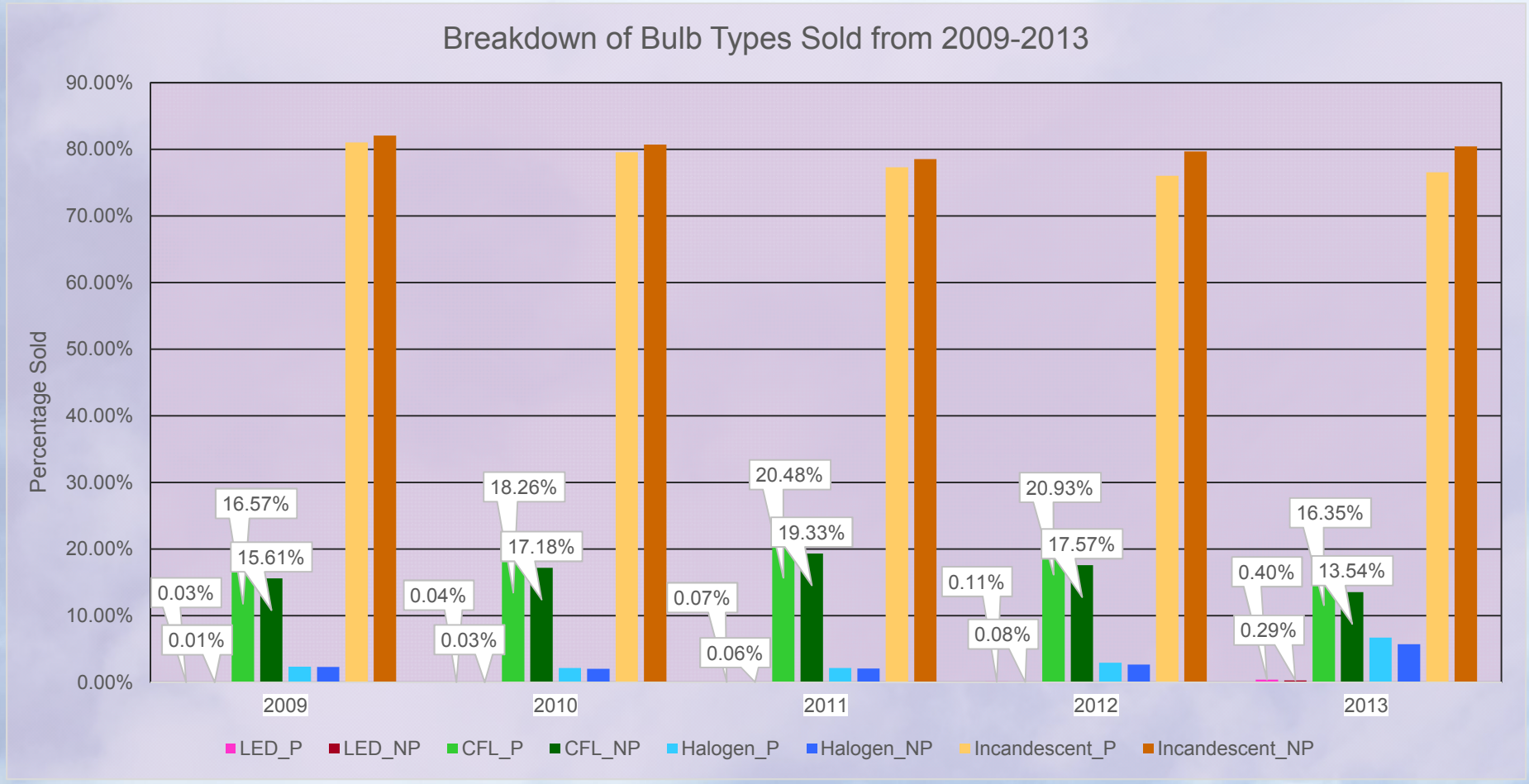
EISA

What does the POS data and the Panel Study reveal about consumers reaction to EISA?

POS: EISA-Market Share of bulb types based on POS data

Year	LED	CFL	Halogen	Incandescent
2009	0.03%	16.41%	2.33%	81.23%
2010	0.04%	18.10%	2.11%	79.75%
2011	0.07%	20.36%	2.13%	77.44%
2012 (EISA 100W)	0.11%	20.59%	2.89%	76.42%
2013 (EISA 75W)	0.39%	16.05%	6.60%	76.97%

POS: EISA-Market share by bulb type for program and non-program.



WHAT REPLACED WHAT?

25%
n = 427

79% 14%
.3% h .1%
△ Watts 6

49%
n = 723

62% 30%
.6% h 1%
△ Watts -31

17%
n = 252

67% 26%
.4% h 3%
△ Watts -36

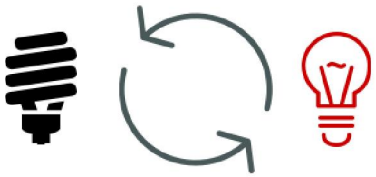
h

2%
n = 40

45% 6%
3% h 45%
△ Watts -9

Linear fluorescents only replaced other linear fluorescents

IMPACT OF STORAGE



30% Efficient to inefficient change outs due to storage

5% Inefficient to efficient changes outs due to storage

Enough bulbs to fill 30% of sockets!

2 in 3 Stored bulbs

1 in 2 Installed from storage

9% Stored bulbs installed

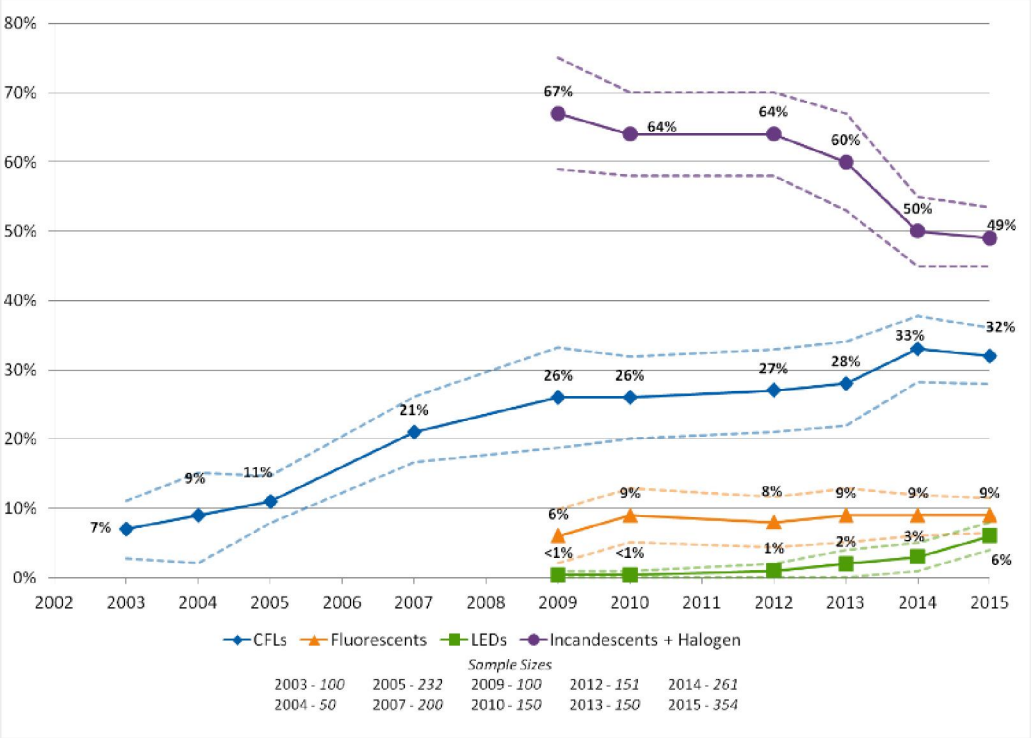
11% Disposed of or given away

Methodology

What steps were taken to get reliable results from the work done Onsight?

METHODS

- Long history
- Attempted before
- Consistency is key
- Protocols and standards
- Care to reduce non-response bias
- Analysis of reactive effects



High response and retention rates

High participant satisfaction

Oversample often overlooked groups

15 Secret Tips That Will Change Everything You Think You Know About On-Sites

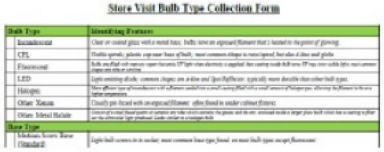
NMR Group, Inc.
Kiersten von Trapp, Scott Walker, and David Barclay, NMR Group, Inc.;
Matt Nelson, Eversource

"The quality of a survey is best judged not by its size, scope, or prominence, but by how much attention is given to [preventing, measuring, and] dealing with the many important problems that can arise."
(Ferber et al. 1980)

Innovation

Innovative Training of Technicians: Dedicating the time and resources to training vastly improves data quality and substantially reduces error.

1 **Independent Training:** Three self-training tasks—a store visit, a thorough review of the on-site protocols, and a mock site visit.



2 **In-Person Training:** Classroom and real-world training in which each technician leads a full on-site visit accompanied by a trainer.

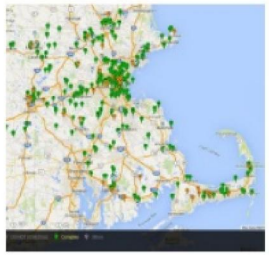
Standardization

Standardization and Simplification of Data Collection: Develop a series of standardized data collection tools and reference materials to guide technicians through their on-sites and minimize data collection errors.

3 **Electronic Data Capture Forms**: Customized data collection software that enables the on-sites to be completed on a tablet computer.

4 **Comprehensive Project-Specific Handbook**: A single-source reference guide for all protocols, definitions, and data collection instructions used for the on-site project.

5 **Site Schematics**: A sketch of the site helps technicians orient themselves, aids in QA/QC, and greatly enhances panel studies.



6 **Detailed On-site Protocols**: Designed to guide technicians through the on-site, starting as soon as they encounter the customer and directing them through the entire process of the on-site.

7 **Careful and Systematic Scheduling**: Using mapping software, scheduling on-sites that are geographically proximate in order to provide technicians with sufficient time to complete high-quality data collection.

8 **For Panel Studies—Leave a Mark**: Identifying a bulb, HVAC system, appliance, or household electronic device with a small mark or a sticker allows data to be compared over time.

Quality Control

Real-Time Quality Control: Quality control measures allow for early identification of errors or inconsistencies and for any necessary adjustments to be made to the protocols or technician staffing.

9 **Daily Data Checks**: Techs sync data every night and every morning; NMR checks data promptly and follows up with clarification questions.

10 **Revisits**: Revisit sites from each tech in the first two weeks after training. This allows for immediate correction and retraining for anything that may not meet standards.

11 **Quality Checks**: Call 20% of homes to ensure that their experience was smooth and the tech was polite and professional.

Communication

Communication and Consideration with On-site Technicians: Clear communication and flexibility with technicians, along with opportunities for feedback, create a work environment in which technicians can thrive and collect high-quality data; a happy technician leads to a better data set.

12 **Access for Techs**: Have a supervisor available to the tech at all times to answer calls, texts, or emails regarding data, site, or scheduling questions.

13 **Flexible Scheduling**: Allow for techs to block off some days or times that they are not available or would prefer not to work. Flexible scheduling helps to avoid burnout. The schedule is updated in real time—when they sync, their schedule is updated automatically.

14 **Use Local Resources**: Using local technicians makes overnights only occasionally necessary. Additionally, local techs are familiar with the area.

15 **Take Advantage of Feedback**: Solicit feedback during the project and adjust as needed. Send out an evaluation survey at the end asking techs for feedback on their experiences and any input for next time around.

Store Sampling Methodology

- **Program State:** random sample stratified on population density to provide diverse cross-section
- **Non-Program State:** nearest-neighbor matching to provide direct comparability
  - Minimized Euclidian distance between z-scores:

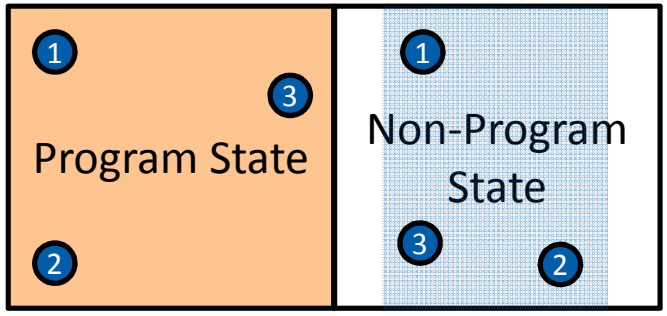
$$z = \frac{x - \bar{x}}{\sigma}, \qquad \min \sqrt{\sum_{i=1}^{charcs} (z_i - z_i')^2}$$

Characteristics:

- Population density within a 10-mile radius
- Median household incomes within a 10-mile radius
- 2012 presidential voting records at the county level
- Estimated store sizes (only where notable variation)

Store Sampling Methodology
(continued)

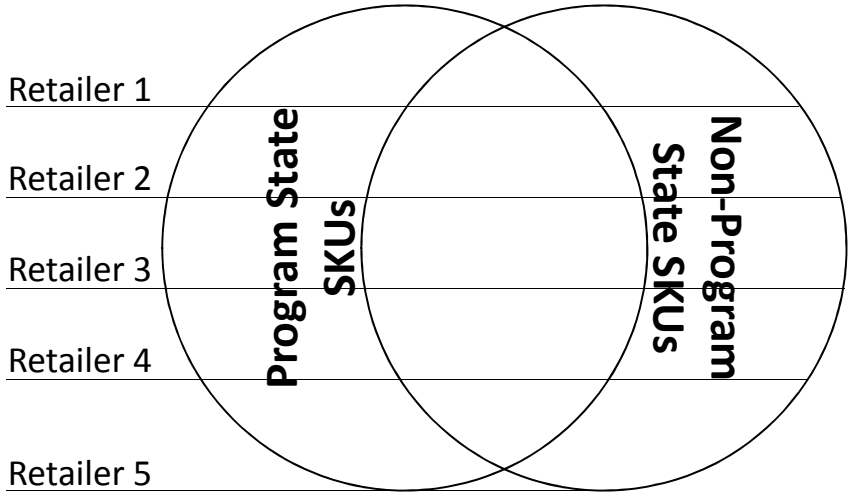
- Excluded Non-Program State counties bordering Program State to limit leakage, counties with prohibitive driving times (opposite border)

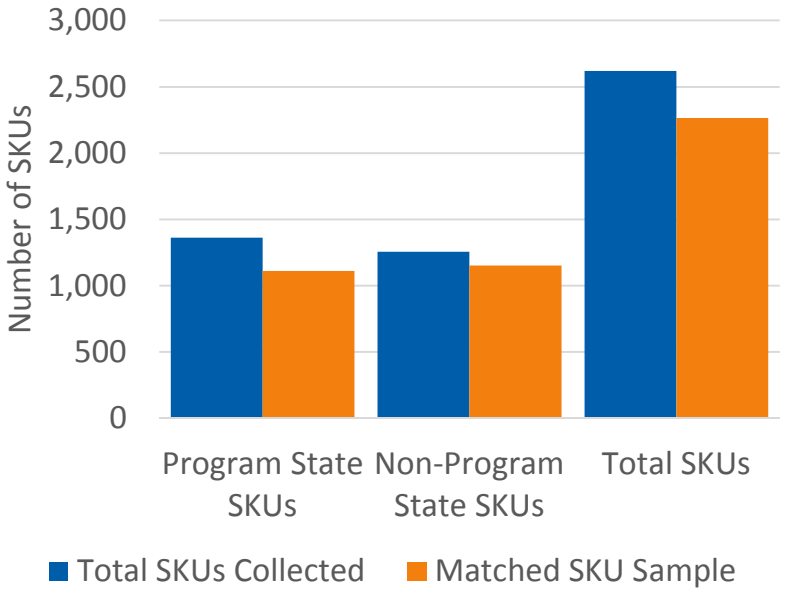


- Seven of 12 Non-Program State stores turned away field staff, and were substituted with the next-nearest matches

Lamps Comparisons

- Incandescent and halogen A-lamps, standard and specialty CFLs and LEDs
- Limited to same lamp SKUs found at same retailer in both states, 86% of total collected





DISSCUSSION

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