

# Identifying and Mitigating Common Self-Reporting Errors in Energy Surveys

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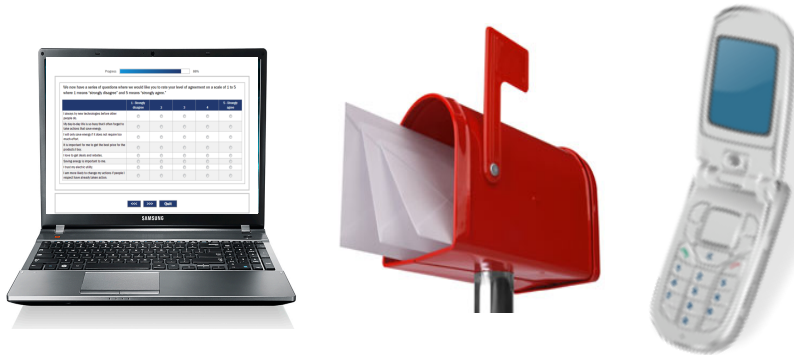
# Reasons for “Energy” Surveys

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- **Measure verification:** Did they install something? Is it still there?
- **NTG / program influence:** Would they have taken a **program action *without the program***? What else were they planning on doing with equipment?
- **Baseline studies / opportunity sizing:** How many households have certain types of equipment? At what **efficiency levels**?
- **Behavioral program engagement:** How have they engaged with program (portal, IHD)? **How frequently** have they engaged?
- **“Pre” conditions:** What did they do/have **before** the program?

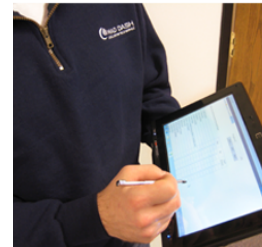
# Data Collection Trade-offs

## Administration Costs



### Self-Report Methods (online, mail, phone):

- ✓ Only source for many questions
- ✓ Standardized
- ✓ Guided (phone)
- ✗ Attention
- ✗ Recall
- ✗ Knowledge



Source: Mad Dash Field Services



### On-Site Verification (audits, metering):

- ✓ (More) accurate
- ✓ Comprehensive
- ✗ Hard to schedule
- ✗ Intrusive
- ✗ Equipment errors

# We ask some tough questions

Category	Example	Technical knowledge	Definition issues	Respondent involvement	Complexity / Cognitive burden	Social Desirability
Equipment Penetration	Presence of CFLs	X		X		X
	Presence of LEDs	X		X		X
	Smart strips	X	X			X
	Insulation			X		
Item Counts	Lighting		X		X	
	TVs		X			
	Computers		X			X
Efficiency Levels	ENERGY STAR status					X
	Lighting is T8 vs. T12	X				
Building Characteristics	Residential square footage		X		X	X
	Commercial square footage		X		X	
	Heating system fuel type	X		X		
	Water heater fuel type	X		X		
Hours of use	Lighting Hours of Use			X	X	
	Business hours				X	
Temperature Setpoints	CAC		X		X	X
	Heating		X		X	X
	Water heater	X	X	X		
Age	Appliance / equipment age			X		
	Age of home		X	X		
Past Actions	Past program participation		X	X		

What does it look like?

Who installed them?

Count overhead and plug-in?

In-use or in storage?

Too many to count

Count basement? Common areas?

I can see radiators...

$(30 \times 24) + (10 \times 14) +$

Setpoint or actual temp?

It depends on the day

Bought by previous owners

Terminology

# Thanks to much wiser contributors

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**Tami Buhr,**  
Director of Survey  
Research



**Katherine Randazzo,**  
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Project Analyst

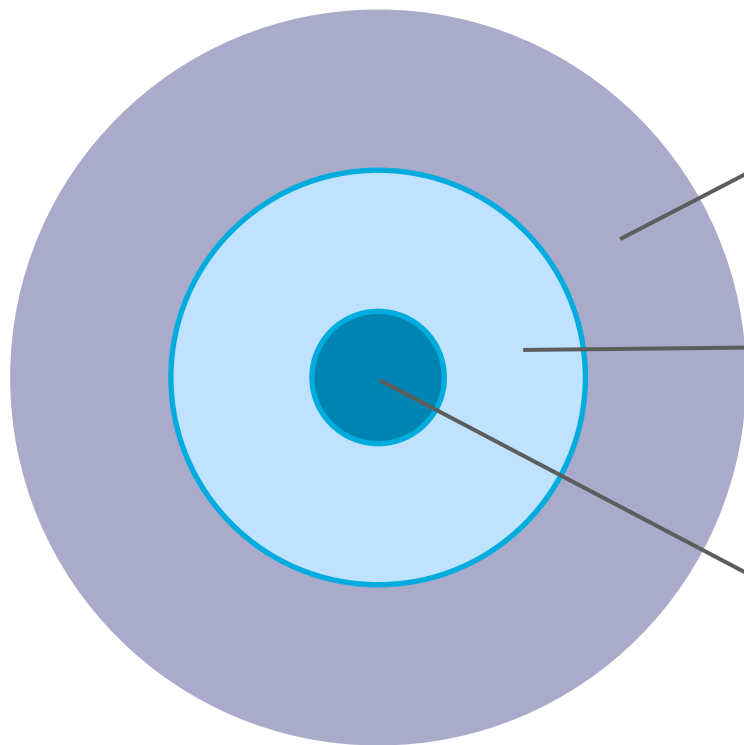


**Garrick Wahlstrand,**  
Senior Analyst

# Learning from nested samples

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- Any systematic differences? What is the role of question structure vs. method?



## Self-Report (telephone or mail)

- Penetration/saturation
- Behavioral, operational & maintenance practices

## Site Visits

- Penetration/saturation
- Equipment technical specifications
- Verified settings / set points

## Metering / Light logging

- Run-time / Lighting HOU
- Occupancy



# Equipment Penetration Examples

Subtitle



# Residential CFL Penetration: 3 Studies

		Study #1	Study #2	Study #3
Description	Self-Report Method	Phone Survey	Phone Survey	Mail Survey
	Verification Method	Site Audit	Site Audit	Site Audit
	Nested n	214	70	228
Results (% Agreement)	Overall Agreement	91%	94%	85%
	Among self-reported "Yes"	99%	97%	88%
	Among self-reported "No"	44%	67%	55%

Read as: 88% of respondents who said they had CFLs, were verified to have CFLs by auditors.



# Res. CFL Study 2



Agreement between customer and auditor reports of having CFLs was much stronger than agreement between reports of not having CFLs

## Respondent 1: Residential Customers Phone survey instrument

CFL1. Have you ever heard of compact fluorescent light bulbs, sometimes called CFLs?

[SKIP THIS PARAGRAPH IF CFL1=1]  
 CFLs, also known as Compact Fluorescent Lamps are light bulbs, **usually shaped in a spiral ("corkscrew") or in a double U-shape** that are advertised as using less energy than normal light bulbs and fit into a regular light bulb socket.

CFL2. [Familiarity question]

CFL3. Do you currently have any CFLs installed inside or outside of your home?

1. Yes
2. No
8. Don't know
9. Refused

## Respondent 2: Site Auditors Instrument on tablet PC

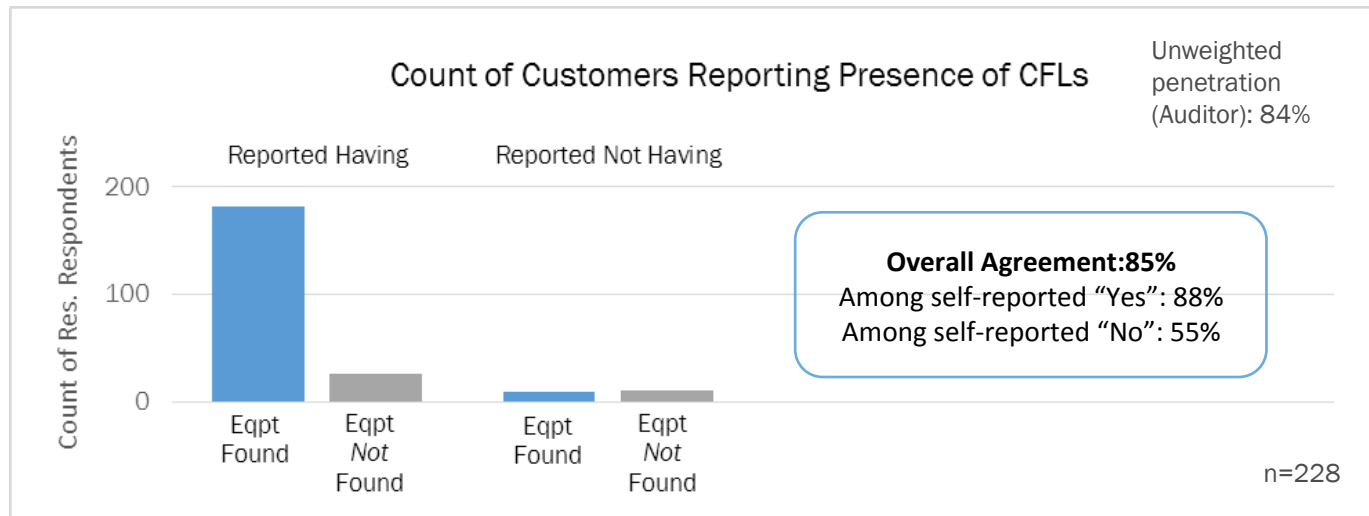
Please enter the following for each type of socket in the room.

- S1. Please select the socket type:
  1. Screw-based
  2. Pin-based
  00. Other, specify
- S2. Please select the control type for this socket:
  1. On-Off
  2. Dimmable
  3. 3-Way
  4. Motion Sensor
  5. Timer
  00. Other, specify
  99. Can't Assess
- S3. Please select the bulb type in this socket:
  1. Incandescent
  2. CFL
  3. Fluorescent
  4. LED
  5. Halogen
  00. Other, specify
  7. Empty

Aided awareness technique – Description of what it looks like

Ask all respondents whether they are installed

# Res. CFL Study 3



Agreement between customer and auditor reports of having CFLs was much stronger than agreement between reports of not having CFLs

Complex question – ask about quantity in same question as definition  
(Preceding question asked approximate # bulbs)

Ranges and answer choices imply meaning and may lead to systematic error

**Respondent 1: Residential Customers**  
Mail survey instrument

J2. Approximately, what percentage of your indoor light bulbs are CFLs? (*The most common type of Compact Fluorescent Light is made with a glass tube bent into a spiral, and it fits in a regular light bulb socket*)

- 0. 0%
- 1. 1-20%
- 2. 21-40%
- 3. 41-60%
- 4. 61-80%
- 5. 81-99%
- 6. 100%

J4. Approximately, what percentage of your outdoor light bulbs are CFLs?

- 0. 0%
- 1. 1-33%
- 2. 34-66%
- 3. 67-99%
- 4. 100%

**Respondent 2: Site Auditors**  
Instrument on tablet PC

Please enter the following for each type of socket in the room.

S1. Please select the socket type:

- 1. Screw-based
- 2. Pin-based
- 00. Other, specify

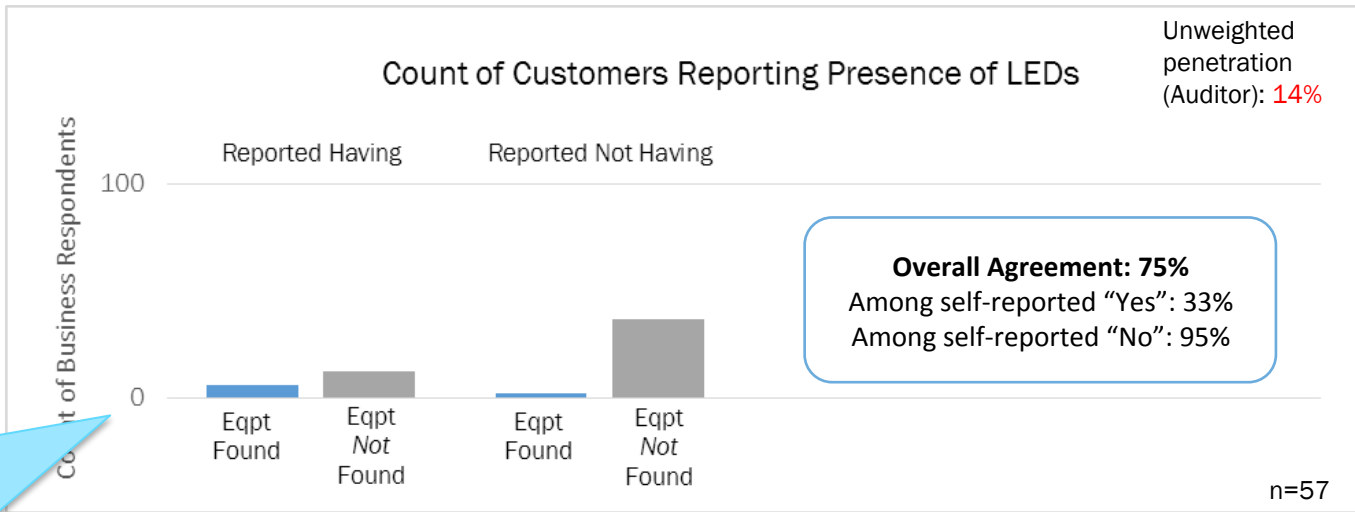
S2. Please select the control type for this socket:

- 1. On-Off
- 2. Dimmable
- 3. 3-Way
- 4. Motion Sensor
- 5. Timer
- 00. Other, specify
- 99. Can't Assess

S3. Please select the bulb type in this socket:

- 1. Incandescent
- 2. CFL
- 3. Fluorescent
- 4. LED
- 5. Halogen
- 00. Other, specify
- 7. Empty

# Residential LED Penetration



With low-penetration measure (14%), there is greater agreement among the more common "no" responses.

Unaided (no definition)

**Respondent 1: Residential Customers**  
 Phone survey instrument

LED1. Have you ever heard of LED light bulbs that can be used to replace standard light bulbs in your home?

1. Yes
2. No
8. (Don't know)
9. (Refused)

[ASK IF LED1 = 1]

LED2. Have you ever installed an LED bulb in your home?

1. Yes
2. No
8. (Don't know)
9. (Refused)

**Respondent 2: Site Auditors**  
 Survey instrument on tablet PC

Enter the following for each type of socket in the room.

S1. Please select the socket type:

1. Screw-based
2. Pin-based
00. Other, specify

S2. Please select the control type for this socket:

1. On-Off
2. Dimmable
3. 3-Way
4. Motion Sensor
5. Timer
00. Other, specify
99. Can't Assess

S3. Please select the bulb type in this socket:

1. Incandescent
2. CFL
3. Fluorescent
4. LED
5. Halogen
00. Other, specify
7. Empty

# Commercial Lighting Penetration: 3 Types

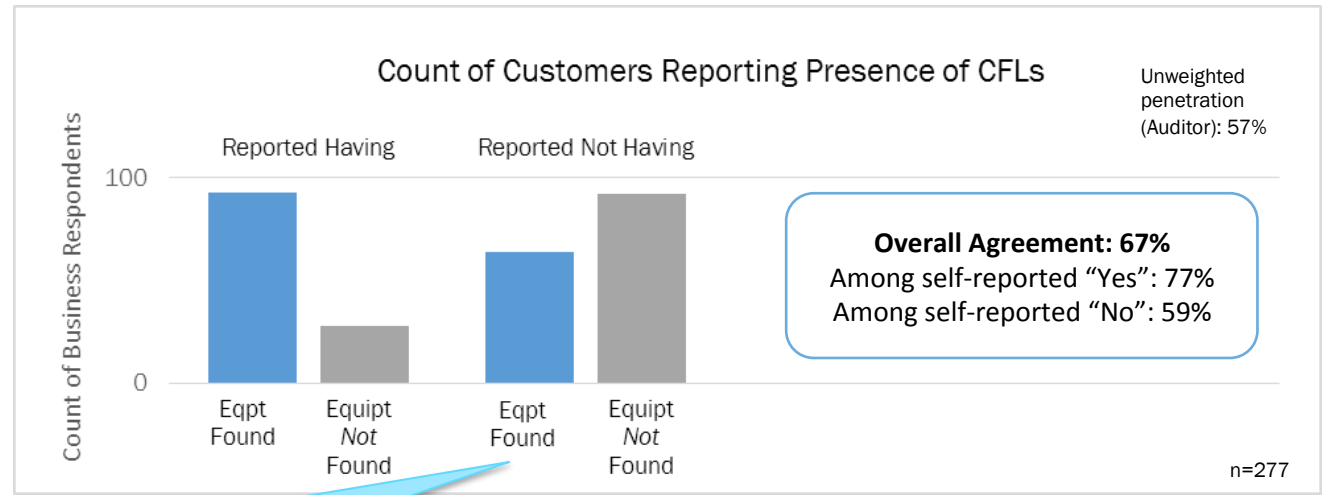
		CFL	Incandescent	Halogen
Description	Self-Report Method	Phone Survey		
	Verification Method	Site Audit		
	Nested n	277	284	283
Results (% Agreement)	Overall Agreement	67%	57%	72%
	Among customers who reported "yes"	77%	68%	27%
	Among customers who reported "no"	59%	48%	81%

Read as: 27% of those who said they had halogens were verified to have by auditors

Agreement was relatively weak for sites *with* a specific kind of lighting, and significantly stronger for sites *without* that kind of lighting



# C&I CFL Penetration



Of those who said they didn't have CFLs, 41% ended up having them!

Did "no" mean "don't know" for these people?

## Respondent 1: Business Customers Phone survey instrument

- IL1. What types of hardwired overhead lighting are installed in your space? Do you have...  
[1=Yes, 2=No, 8=Don't know, 9=Refused]
- a Linear fluorescent lights
  - b Compact fluorescent lights / CFLs
  - c Incandescent bulbs
  - d Metal halide bulbs
  - e High pressure sodium bulbs
  - f Mercury vapor bulbs
  - g Halogen bulbs
  - h LED lights
  - i Neon lights (Cold Cathode)

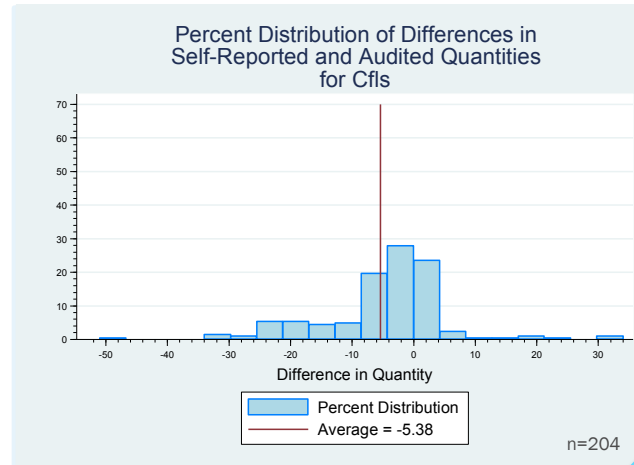
## Respondent 2: Site Auditors Excel table on tablet

Space Type	Fixture Type	Lighting Type	Fixture Quantity	Control Type	Fixture is plugged into wall
Office	Screw base	Incan-descent Exit Signs	5	No Control	No
Office	Pin base	T8 Linear Fluoresce nt	112	Manual switch	No
Office	Screw base	CFLs	26	Manual switch	No
Manu-facturing	Pin base	T8 Linear Fluoresce nt	109	Manual switch	No
Manu-facturing	Pin base	T8 Linear Fluoresce nt	8	Occu-pancy sensor	No

# Counts



# Residential CFLs: Counts



Mean # CFLs found by auditors was 14.5, so this is a big difference.

On average, customers report having 5.4 fewer CFLs than auditors found

Started with quantity rather than yes/no; Respondents can say "none"

**Respondent 1: Residential Customers**  
Phone survey instrument

*Read if customer indicates not being immediately familiar with CFLs:*  
Compact fluorescent light bulbs – also known as CFLs usually do not look like regular incandescent light bulbs. The most common type of CFL is made with a glass tube bent into a spiral, resembling soft-serve ice cream, and it fits in a regular light bulb socket. Based on this description, do you think you have heard of compact fluorescent light bulbs?

Q6. Approximately how many compact fluorescent light bulbs do you currently have installed?

\_\_\_\_\_ Number of interior compact fluorescent light bulbs (CFLs)

8. (Don't know)  
9. (Refused)

**Respondent 2: Site Auditors**  
Instrument on tablet PC

Please enter the following for each type of socket in the room.

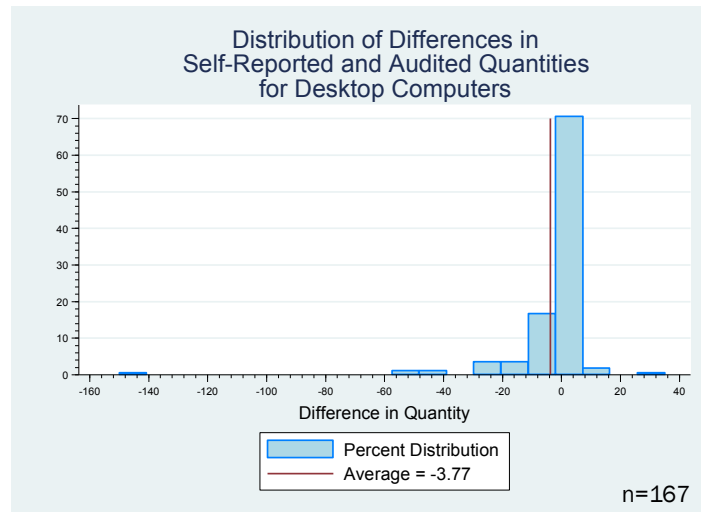
S1. Please select the socket type:  
1. Screw-based  
2. Pin-based  
00. Other, specify

S2. Please select the control type for this socket:  
1. On-Off  
2. Dimmable  
3. 3-Way  
4. Motion Sensor  
5. Timer  
00. Other, specify  
99. Can't Assess

S3. Please select the bulb type in this socket:  
1. Incandescent  
2. CFL  
3. Fluorescent  
4. LED  
5. Halogen  
00. Other, specify  
7. Empty

# Commercial: Desktop Computer Counts

Mean # desktops found by auditors was 18.3, so this is a sizable difference.



On average, customers reporting having 3.4 fewer desktop computers than auditors found

Respondent 1: Business Customers  
Phone survey instrument

CE1 Which of the following office equipment do you have at your business? Do you have (a)... [1=Yes, 2=No, 8=Don't know, 9=Refused]

- a Desktop computers
- b Laptop computers
- c Printers (If needed: Stand-alone)
- d Multi-function device
- e Scanner (If needed: Stand-alone)
- f Copy machine (If needed: Stand-alone)
- g Television
- h Retail registers
- i Servers

[REPEAT CE2-CE5 FOR EACH <CE MEASURE> in CE1a-CE1g=1]

CE2 How many <CE MEASURE>s are in regular use at your facility?

Respondent 2: Site Auditors  
Excel table on tablet

Space Type	Type	Quantity	Energy Star	Avg Screen Size	Screen Type
Office	Desktop computer	13	No	17	Flat screen
Office	Desktop computer	7	Yes	15	CRT
Office	Laptop computer	2	Yes	15	
Office	Desktop computer	3	Yes	21	Flat screen
Office	Desktop computer	2	Yes	24	Flat screen
Office	Desktop computer	22	Yes	15	Flat screen
Office	Desktop computer	13	No	17	Flat screen
Office	Desktop computer	7	Yes	15	CRT



# Hours

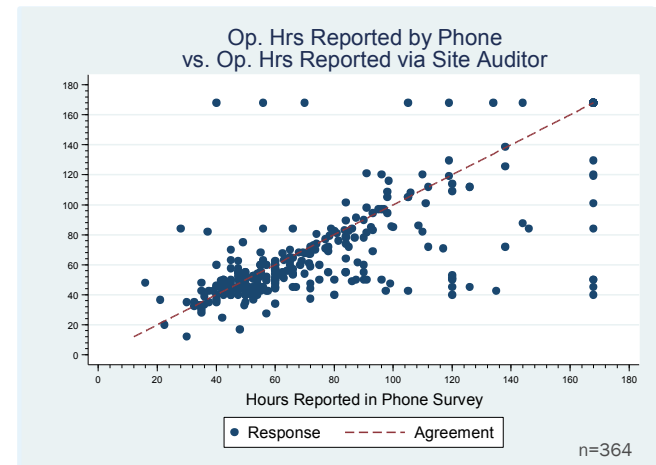
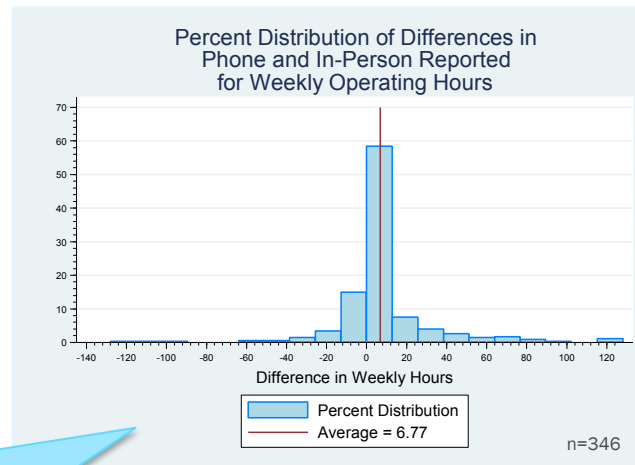
## Subtitle



# Commercial Business Hours of Use (Weekly)

Customers reported operating 6.8 hours longer than they reported when prompted by an auditor (a 16.7% difference)

On phone, customers have to think of “typical” weekday; on site, they were walked through each day.



Respondent 1: Business Customers  
Phone Survey Instrument

[Earlier questions establish what days-of-week business is open]

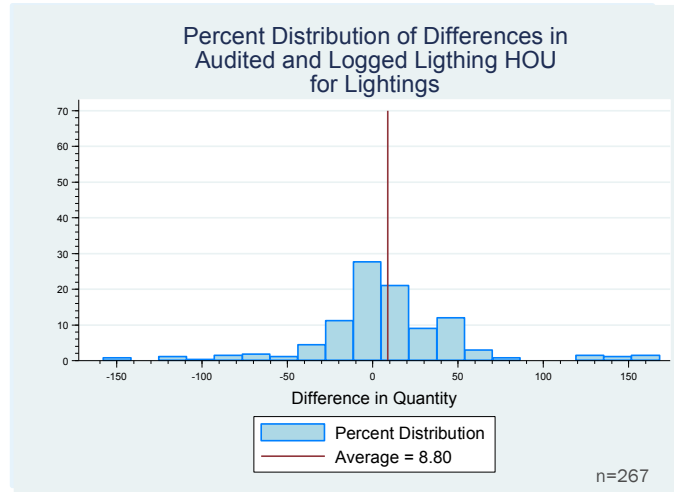
- H3 On weekdays, At what time does your company start operating?
- H3a (Enter hours and minutes, e.g., 0530 for 5:30 (IF 24 hours, enter 2400))
- H3b (AM / PM)
- H4 On weekdays, At what time does your company typically finish operating?
- H4a (Enter hours and minutes)
- H4b (AM / PM)

Respondent 2: Business Customers via Auditor  
Excel table on tablet

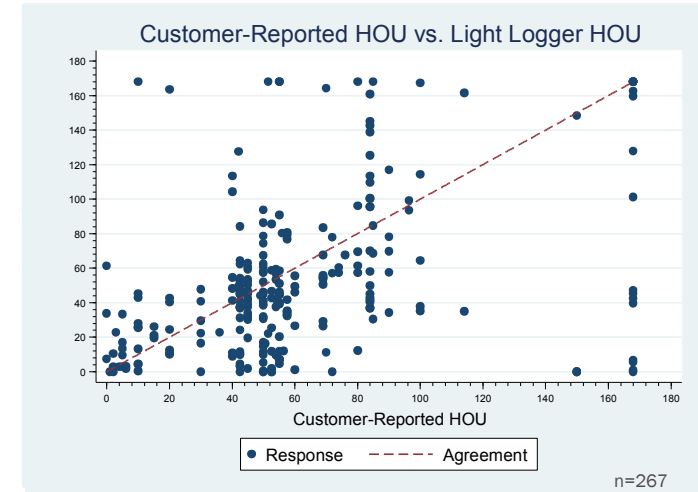
Day	Start Time	Stop Time	Open 24 Hours	Closed 24 Hours	Same as prev. day?
Mon	6:00 AM	4:30 PM			
Tues	6:00 AM	4:30 PM			1
Wed	6:00 AM	4:30 PM			1
Thurs	6:00 AM	4:30 PM			1
Fri	6:00 AM	4:30 PM			1
Sat				1	0
Sun				1	1

# Commercial Lighting Hours of Use

Mean HOU found by loggers was 52.1, so this is a meaningful difference.



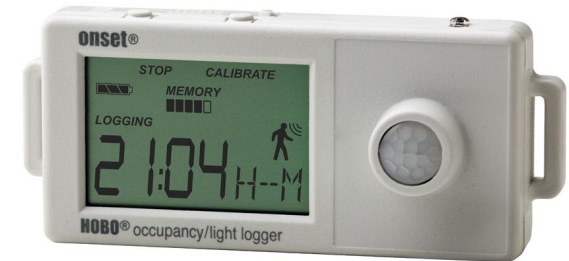
On average, customers reported leaving lights on for 8.8 hours *longer* than light loggers



Respondent 1: Business Customers (via Auditors).  
Recorded in Excel on tablet

Space Type	Lighting Type	Fixture Quantity	Control Type	Hours On are Same as Business Hours	Hours On per week
Office	T8 Linear Fluorescent	4	Manual switch	1	=Bus. Hrs
Office	CFLs	4	Manual switch	1	=Bus. Hrs
Manufacturing	T8 Linear Fluorescent	6	Manual switch	0	60
Manufacturing	T8 Linear Fluorescent	8	Occupancy sensor	0	60

Respondent 2: HOBO Light Loggers



Light on/off and occupancy sensors

# Strategies for Mitigating Errors

Subtitle



# Tools for mitigating errors

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## Survey instrument & question design

1. Prioritize based on goals/intentions
2. Be reasonable with what you request
3. Pre-test & monitor (*test outside our industry!*)
4. “Decompose” complicated questions (*includes warm-up questions*)
5. Define ambiguous/unfamiliar terms (*...and if you’re going to aid, aid everyone*)
6. Provide response categories that don’t suggest an anchor or appropriate answer

## Additional data collection

1. Gather site data as basis for adjustment

Be reasonable with what you request, and consider tradeoffs!

# Tip 3. Pre-test, monitor, and test some more

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## Pre-Test

- Listen to testers' questions, cognitive processes
- Ask your friends and family (outside of the industry!) to take survey

## Monitor

- Listen to first 5-10 interviews to identify hurdles and misunderstandings. When found:
  - Modify instrument or write in "aids:
  - Train staff to deal with complex issues
- Examine data from first 20-30 responses for:
  - Timing & non-complete rates
  - Persistent "don't know" responses
  - Scales with little variation (i.e., all at low or high end)

## Experiment

- Randomly assign respondents to different survey versions to compare similar phrases of interest

# Tip 4: “Decompose” complicated questions

- Break questions with high cognitive burden into smaller pieces
  - “What hour do you open on Monday” rather than “What are your hours on a typical day”?

## Typical Weekday

[Earlier questions establish what days-of-week business is open]

H3 On weekdays, At what time does your company start operating?

H4 On weekdays, At what time does your company typically finish operating?

## Every Weekday

Day	Start Time	Stop Time	Open 24 Hours	Closed 24 Hours	Same as prev. day?
Mon	6:00 AM	4:30 PM			
Tues	6:00 AM	4:30 PM			1
Wed	6:00 AM	4:30 PM			1
Thurs	6:00 AM	4:30 PM			1
Fri	6:00 AM	4:30 PM			1
Sat				1	0
Sun				1	1



# Tip 5: Clarify definitions and define unfamiliar terms

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- Goals may be different for close-ended or open-ended questions
- If you're going to aid (definition, awareness), aid for *everyone*

## Aid for some

CFL1. Have you ever heard of compact fluorescent light bulbs, sometimes called CFLs?

[READ IF NOT AWARE]

CFLs, also known as Compact Fluorescent Lamps are light bulbs, **usually shaped in a spiral (“corkscrew”) or in a double U-shape** that are advertised as using less energy than normal light bulbs and fit into a regular light bulb socket.

CFL2. Do you currently have any CFLs installed inside or outside of your home?

## Aid for everyone

CFL1. Have you ever heard of compact fluorescent light bulbs, sometimes called CFLs?

[IF AWARE: *As you may know,*] The most common type of Compact Fluorescent Light is made with a glass tube bent into a spiral, and it fits in a regular light bulb socket)

CFL2. Do you currently have any CFLs installed inside or outside of your home?





## Example: Clarify definitions

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- Have you smoked a cigarette in the last week?
  - 23% thought to count only finished cigarettes
  - 23% thought to count partially smoked cigarettes
  - 54% thought to count a puff or two

*Source: Suessbrick, Schober & Conrad (2000).*



## Tip 6: Be careful about response categories or wording that may anchor responses

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- Choosing how you define ranges or response categories can be very important, and response categories that work for one type of question may not work for another

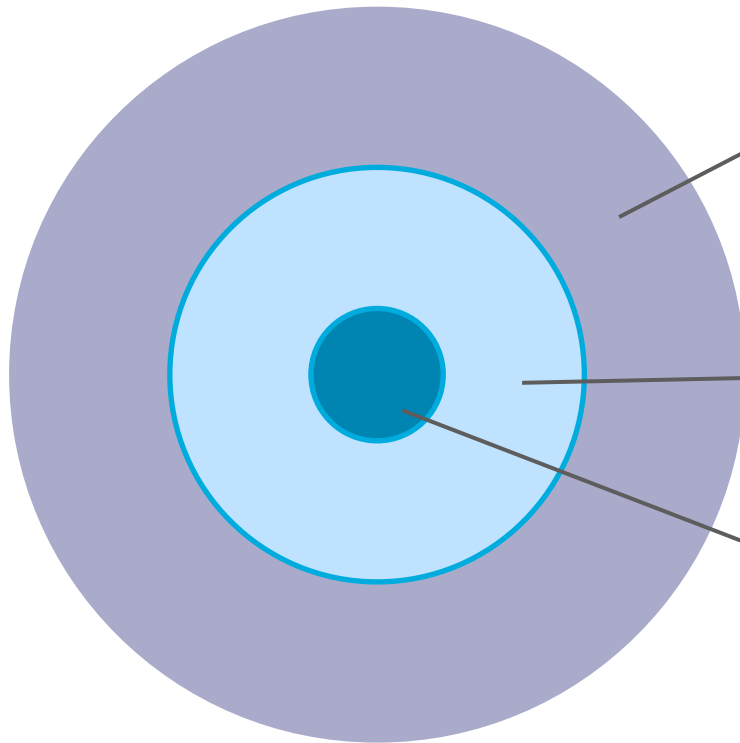
**J1** Approximately, how many light bulbs are installed inside your home?

1 0-9     2 10-19     3 20-29     4 30-39     5 40-49     6 50-59     7 60 or more

Ranges in middle of scale may suggest this is where the “average” person may fall – Check other sources before setting ranges



# Example: Using site visit data to correct / adjust



**Telephone Interviews: 1,519 sites**

- Penetration/saturation
- Behavioral, operational & maintenance practices

**Site Visits: 347 sites**

- Penetration/saturation
- Equipment technical specifications
- Verified settings / set points

**Light Logging: 70 sites**

- Lighting HOU
- Occupancy

*Nested Sample provides opportunity to compare & adjust self-reported responses with site visit data*



# Adjustment Ratio Methodology: Step 1

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- Pearson's chi-squared test on questions we considered for adjustment.
- If the test showed that mail survey responses are significantly different from on-site observations, we calculated an adjustment ratio

# Adjustment Ratio Example: Step 2

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## Mail vs. On-Site Audit Report of Having Screw-in LEDs Among Customers with BOTH data types

	Mail Self-Report	On-Site Audit Findings	Adjustment Factor
<i>n</i>	180	180	
Have LEDs	34%	6%	= 6%/34% = <b>0.17</b>
Do Not have LEDs	66%	94%	= 94%/66% = <b>1.44</b>



# Adjustment Ratio Example: Step 3

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- Apply ratios to entire sample of mail survey responses:

	Mail Self-Report	Adjustment Factor	Adjusted n
Have LEDs (n)	1,600	0.17	= 1600 * .17 = 272
Do Not have LEDs (n)	2,500	1.44	= 2500 * 1.44 = 3,600

$$\text{Adjusted Penetration} = 272 / (272 + 3600) = 7\%$$

- A final adjustment step is necessary to obtain correct valid  $n$  that matches original data



# Thank You

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Visit us at [www.opiniondynamics.com](http://www.opiniondynamics.com) to take our Energy Efficiency Industry Survey for your chance to win an iPad!

# Additional Survey Design Tips

Subtitle



# Tip 1. Consider implications and trade-offs, and prioritize

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- Adding additional questions or complexity to surveys can provide additional information at a fraction of the cost of other methods
- **But** you may lower response rates and reduce the quality of information gathered
- Some inaccuracies have long-term implications
  - Asking questions about newer technology can be very important to gather a market baseline
  - But if participants don't understand your questioning and responses are wrong, it can create many issues down the line

## Tip 2. Be reasonable with what you request

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- Just because you *can* ask a question doesn't mean you *should*
  - If you can't dedicate time (and budget) to warming up participants, adding aids, and decomposing questions, consider not asking.
- Some topics just may not be suitable for self-report
  - For example, baseline studies:
    - Good for self-reports of CFL penetration
    - Not good for self-reports of (a) newer technologies and (b) CFL saturation.
- Use “about” in questions for topics where precision or knowledge of fine detail is unlikely
  - And make sure people feel comfortable saying “don't know”

# Appendix: Visual Display

# Tip 5: Make Presentation/Visuals Clear

## E5 Which of the following rooms are heated by each type of electric heat?

*(Please check all that apply for each heater. If you do not use a type of heater, check "Not Used")*

	<u>A. Resistance /</u> Baseboard Heaters	<u>B. Heat Pump</u>	<u>C. Portable</u> Space Heaters	<u>D. Other</u> Electric Heat
Bedroom	1 <input type="checkbox"/>	1 <input type="checkbox"/>	1 <input type="checkbox"/>	4 <input type="checkbox"/>
Bathroom	2 <input type="checkbox"/>	2 <input type="checkbox"/>	2 <input type="checkbox"/>	4 <input type="checkbox"/>
Kitchen	3 <input type="checkbox"/>	3 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
Living/Family Room	4 <input type="checkbox"/>	4 <input type="checkbox"/>	4 <input type="checkbox"/>	4 <input type="checkbox"/>
Den/Office	5 <input type="checkbox"/>	5 <input type="checkbox"/>	5 <input type="checkbox"/>	4 <input type="checkbox"/>
Dining Room	6 <input type="checkbox"/>	6 <input type="checkbox"/>	6 <input type="checkbox"/>	4 <input type="checkbox"/>
Finished Basement	7 <input type="checkbox"/>	7 <input type="checkbox"/>	7 <input type="checkbox"/>	4 <input type="checkbox"/>
Not used	8 <input type="checkbox"/>	8 <input type="checkbox"/>	8 <input type="checkbox"/>	4 <input type="checkbox"/>

- When working with mail/email surveys, make presentation/visuals clear; make sure visuals don't suggest conventional/specific answers



# Tip 5: Make Presentation/Visuals Clear

## E5 Which of the following rooms are heated by each type of electric heat?

*(Please check all that apply for each heater. If you do not use a type of heater, check "Not Used")*

	<u>A. Resistance /</u> Baseboard Heaters	<u>B. Heat Pump</u>	<u>C. Portable</u> Space Heaters	<u>D. Other</u> Electric Heat
Bedroom	1 <input type="checkbox"/>	1 <input type="checkbox"/>	1 <input type="checkbox"/>	4 <input type="checkbox"/>
Bathroom	2 <input type="checkbox"/>	2 <input type="checkbox"/>	2 <input type="checkbox"/>	4 <input type="checkbox"/>
Kitchen	3 <input type="checkbox"/>	3 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
Living/Family Room	4 <input type="checkbox"/>	4 <input type="checkbox"/>	4 <input type="checkbox"/>	4 <input type="checkbox"/>
Den/Office	5 <input type="checkbox"/>	5 <input type="checkbox"/>	5 <input type="checkbox"/>	4 <input type="checkbox"/>
Dining Room	6 <input type="checkbox"/>	6 <input type="checkbox"/>	6 <input type="checkbox"/>	4 <input type="checkbox"/>
Finished Basement	7 <input type="checkbox"/>	7 <input type="checkbox"/>	7 <input type="checkbox"/>	4 <input type="checkbox"/>
Not used	8 <input type="checkbox"/>	8 <input type="checkbox"/>	8 <input type="checkbox"/>	4 <input type="checkbox"/>

This row means something different (not the same as other categories) – needs to be separated out in some way

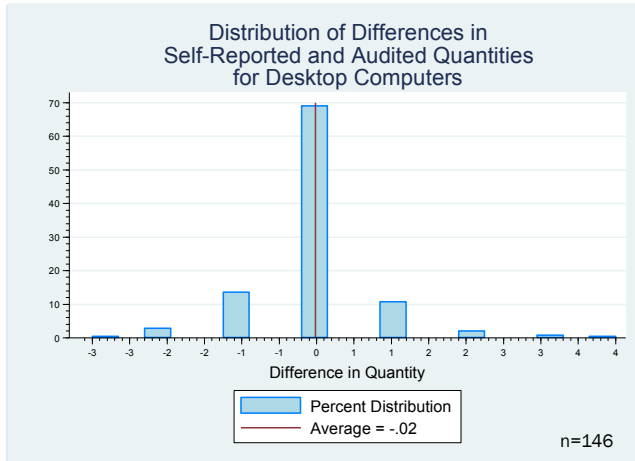
- When working with mail/email surveys, make presentation/visuals clear; make sure visuals don't suggest conventional/specific answers

# Appendix: Counts



# Residential: Desktop Computer Counts

Talking about what “in use” or “plugged in” yields more relevant counts, and may minimize discrepancies



On average, customers report having the same number of computers as auditors found

## Respondent 1: Residential Customers Mail Survey Instrument

### H2 How many of the following electronics do you use in this home?

	None	1	2	3	4 or more
a. Cable/satellite box with DVR (digital video recorder)	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
b. Stand-alone cable/satellite box	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
c. Stand-alone DVR (e.g., TiVo)	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
d. Video game player	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
e. Laptop/Tablet	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
f. Desktop Computer	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>

## Respondent 2: Site Auditors Survey instrument on tablet PC

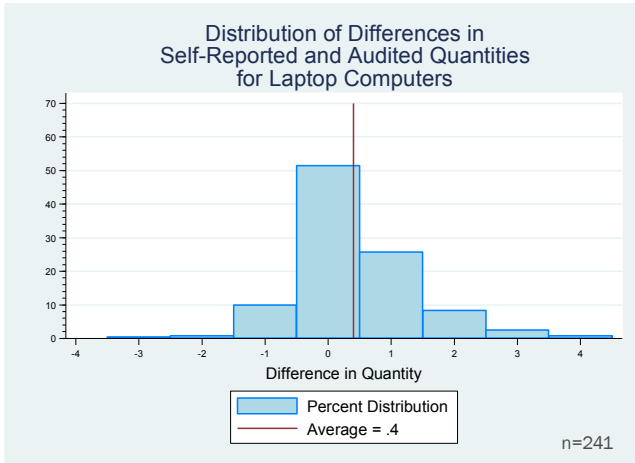
*Looped for each room in the home*

C1. Total number of computers in the room that are plugged in (or, for laptops, in use)  
[NUMERIC OPEN END]

*Asked for each computer observed in the home*

- C2. Please enter computer type:
1. Laptop
  2. Desktop
  3. Tablet/iPad
  99. Can't assess

# Residential: Laptop Computer Counts



On average, customers report having 0.4 more laptops than auditors found

- Some may not be present during audit.
- Differences between laptop/tablet

## Respondent 1: Residential Customers Mail Survey Instrument

### H2 How many of the following electronics do you use in this home?

	None	1	2	3	4 or more
a. Cable/satellite box with DVR (digital video recorder)	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
b. Stand-alone cable/satellite box	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
c. Stand-alone DVR (e.g., TiVo)	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
d. Video game player	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
e. Laptop/Tablet	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>
f. Desktop Computer	0 <input type="checkbox"/>	1 <input type="checkbox"/>	2 <input type="checkbox"/>	3 <input type="checkbox"/>	4 <input type="checkbox"/>

## Respondent 2: Site Auditors Survey instrument on tablet PC

*Looped for each room in the home*

C1. Total number of computers in the room that are plugged in (or, for laptops, in use)  
[NUMERIC OPEN END]

*Asked for each computer observed in the home*

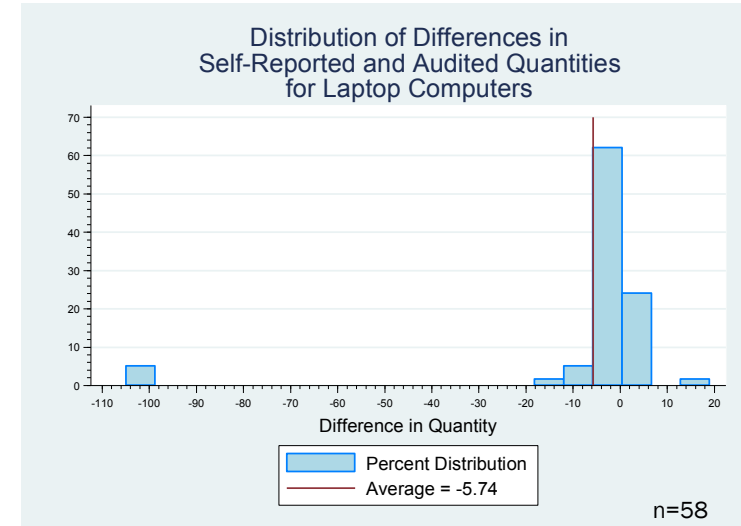
C2. Please enter computer type:

1. Laptop
2. Desktop
3. Tablet/iPad
99. Can't assess



# Commercial: Laptop Computer Counts

Mean # laptops found by auditors was 15.1, so this is a big difference.



On average, customers reporting having 5.7 fewer laptop computers than auditors found

## Respondent 1: Business Customers Phone survey instrument

CE1 Which of the following office equipment do you have at your business? Do you have (a)... [1=Yes, 2=No, 8=Don't know, 9=Refused]

- a Desktop computers
- b Laptop computers
- c Printers (If needed: Stand-alone)
- d Multi-function device
- e Scanner (If needed: Stand-alone)
- f Copy machine (If needed: Stand-alone)
- g Television
- h Retail registers
- i Servers

[REPEAT CE2-CE5 FOR EACH <CE MEASURE> in CE1a-CE1g=1]

CE2 How many <CE MEASURE>s are in regular use at your facility?

## Respondent 2: Site Auditors Excel table on tablet

Space Type	Type	Quantity	Energy Star	Avg Screen Size	Screen Type
Office	Desktop computer	13	No	17	Flat screen
Office	Desktop computer	7	Yes	15	CRT
Office	Laptop computer	2	Yes	15	
Office	Desktop computer	3	Yes	21	Flat screen
Office	Desktop computer	2	Yes	24	Flat screen
Office	Desktop computer	22	Yes	15	Flat screen
Office	Desktop computer	13	No	17	Flat screen
Office	Desktop computer	7	Yes	15	CRT

# Lighting Hours-of-Use adjustment to self-reported data

- On average, facility contacts slightly over-reported average HOU, with a slight variation by space.

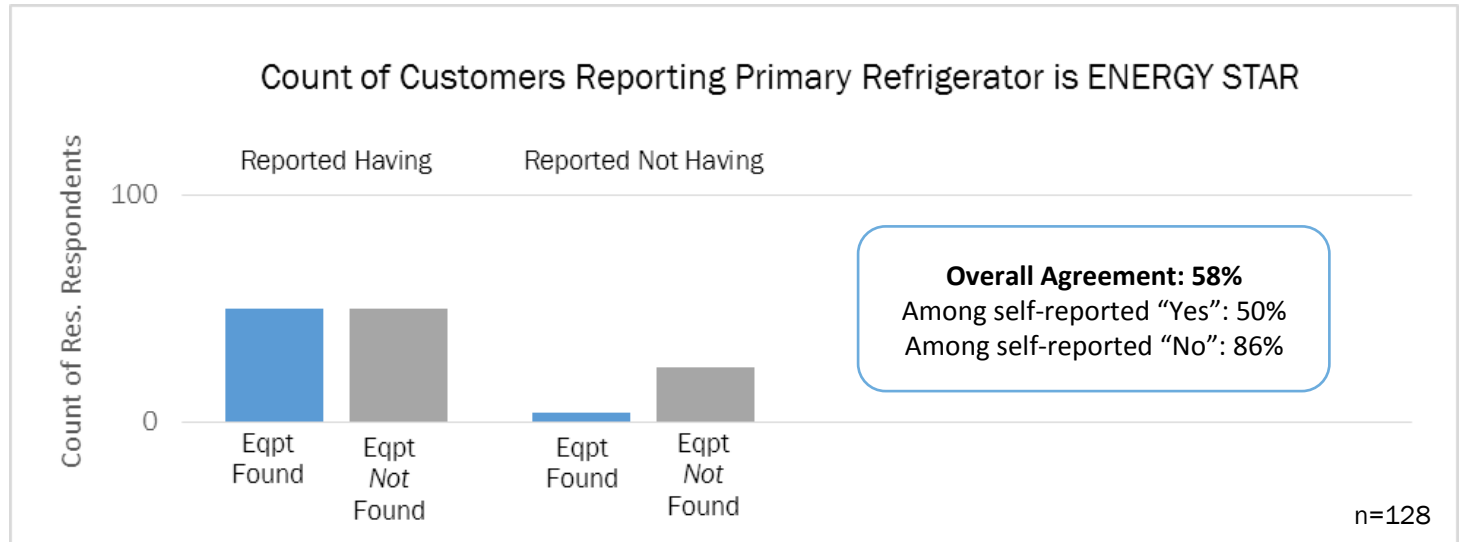
Space Type	Logger n	Hrs/Week reported to Auditor (Wgtd Avg)	Hrs/Week observed with loggers (Wgtd Avg)	Adjustment Ratio
office	118	56.2	45.7	81%
conference room or classroom	22	41.6	36.2	87%
dining area (+food prep)	37	60.4	58.5	97%
hallway/stairwell (+other/all spaces + lobby/atrium)	34	87.5	73.1	84%
storage areas (+fridge storage)	38	61.7	56.3	91%
<b>Total</b>	<b>249</b>	<b>64.5</b>	<b>55.9</b>	<b>87%</b>



# Appendix: Energy Star



# ENERGY STAR Refrigerators



Agreement between customer and auditor reports of *not* having an ENERGY STAR refrigerator was much stronger than agreement between reports of having one

Respondent 1: Residential Customers  
Mail survey instrument

- G10. Does your primary refrigerator have any of the following characteristics?
- a. ENERGY STAR rated
1. Yes
  2. No
  8. Don't know

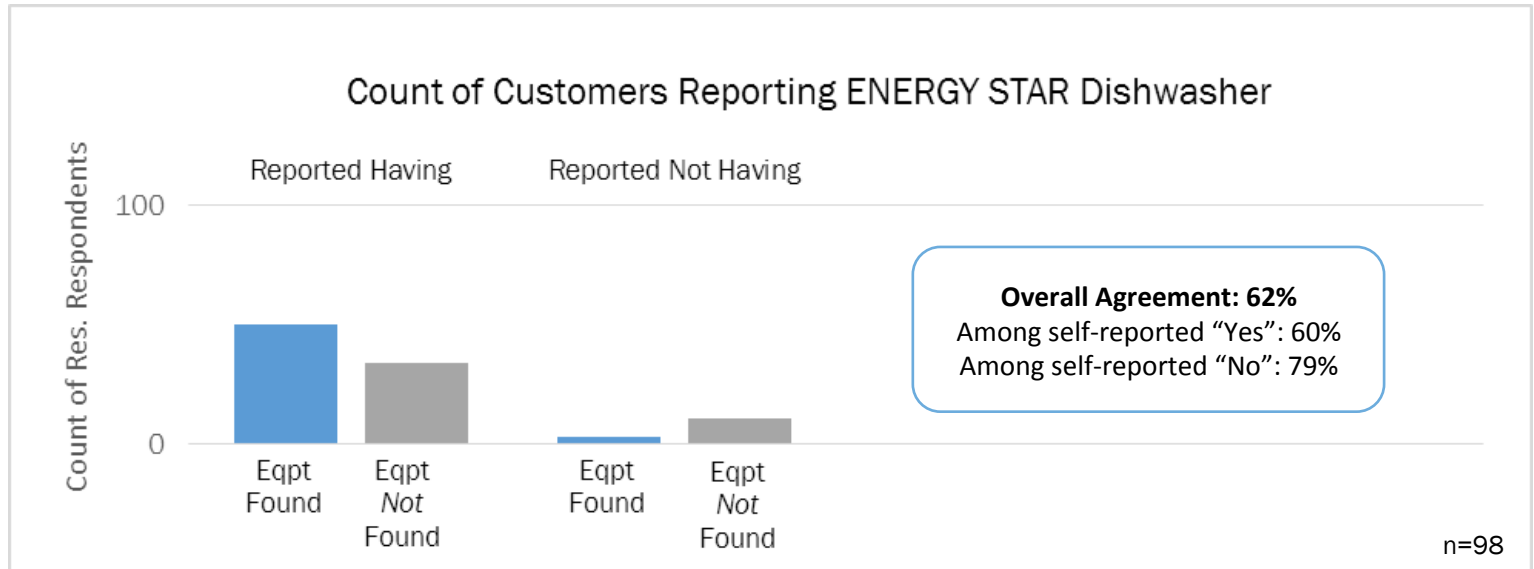
Respondent 2: Site Auditors  
Survey instrument on tablet PC

- RF6. Is the refrigerator ENERGY STAR?
1. Yes
  2. No
  99. Can't assess

[Room also recorded to determine if primary]

Questions requires unaided awareness, but concept is fairly well-known

# ENERGY STAR Dishwashers



Agreement between customer and auditor reports of having an ENERGY STAR dishwasher was much stronger than agreement between reports of not having one – Supports social desirability bias theory

Respondent 1: Residential Customers  
Mail survey instrument

- G10. Is your dishwasher ENERGY STAR rated?
1. Yes
  2. No
  8. Don't know

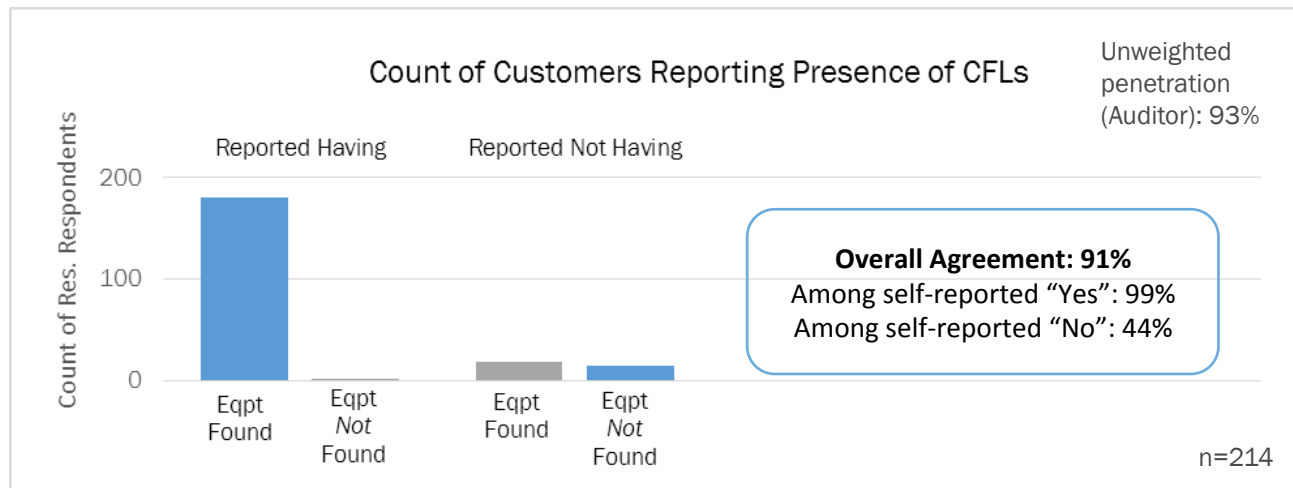
Respondent 2: Site Auditors  
Survey instrument on tablet PC

- DW2. Is the dishwasher ENERGY STAR?
1. Yes
  2. No
  99. Can't assess

Questions requires unaided awareness, but concept is fairly well-known

# Appendix: Lighting Penetration

# Res. CFL Study 1



## Respondent 1: Residential Customers Phone survey instrument

Q3. Have you ever heard of compact fluorescent light bulbs, sometimes called CFLs?

1. Yes
2. No
8. (Don't Know)
9. (refused)

[SKIP TO Q5 IF Q3=1]

Q4. Compact fluorescent light bulbs – also known as CFLs – usually do not look like regular incandescent light bulbs. The most common type of CFL is made with a **glass tube bent into a spiral, resembling soft-serve ice cream**, and it fits in a regular light bulb socket. Based on this description, do you think you have heard of compact fluorescent light bulbs?

1. Yes
2. No
8. (Don't Know)
9. (refused)

[ASK IF AWARE]

Q5. Do you currently have any compact fluorescent light bulbs installed in the interior or exterior of your home?

1. Yes
2. No
8. (Don't Know)
9. (refused)

Aided awareness technique – Description of what it looks like

Asked of Aware Only

## Respondent 2: Site Auditors Instrument on tablet PC

Enter the following for each type of socket in room.

S1. Please select the socket type:

1. Screw-based
2. Pin-based
00. Other, specify

S2. Please select the control type for this socket:

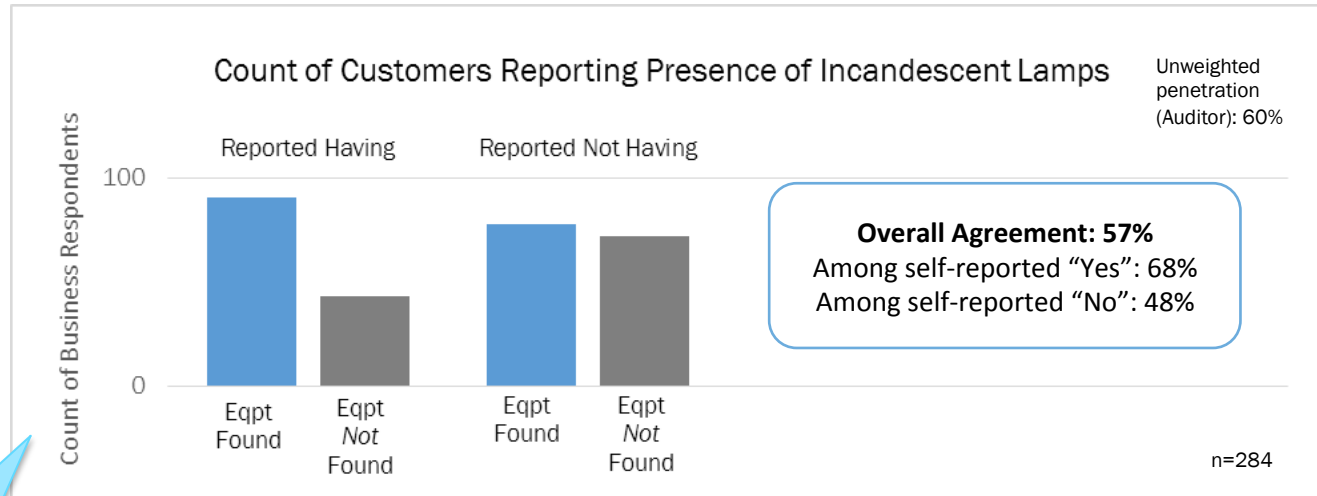
1. On-Off
2. Dimmable
3. 3-Way
4. Motion Sensor
5. Timer
00. Other, specify
99. Can't Assess

S3. Please select the bulb type in this socket:

1. Incandescent
2. CFL
3. Fluorescent
4. LED
5. Halogen
00. Other, specify
7. Empty

# C&I Incandescent Penetration

Agreement is generally lower than for CFLs, but trend is similar – even though CFLs more “green” – Is “incandescent” too technical?



Customers who reported having equipment were more likely to be “verified” than those who reported not having it.

## Respondent 1: Business Customers Phone survey instrument

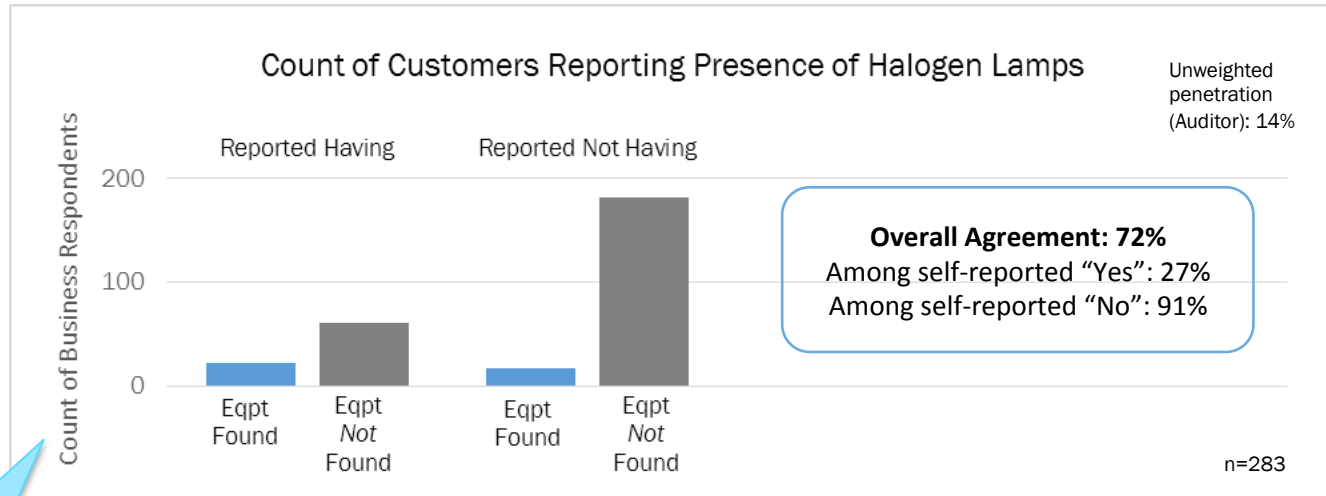
- IL1 What types of hardwired overhead lighting are installed in your space? Do you have...  
[1=Yes, 2=No, 8=Don't know, 9=Refused]
- a Linear fluorescent lights
  - b Compact fluorescent lights / CFLs
  - c Incandescent bulbs
  - d Metal halide bulbs
  - e High pressure sodium bulbs
  - f Mercury vapor bulbs
  - g Halogen bulbs
  - h LED lights
  - i Neon lights (Cold Cathode)

## Respondent 2: Site Auditors Excel table on tablet

Space Type	Fixture Type	Lighting Type	Fixture Quantity	Control Type	Fixture is plugged into wall
Office	Screw base	Incan- descent Exit Signs	5	No Control	No
Office	Pin base	T8 Linear Fluoresce nt	112	Manual switch	No
Office	Screw base	CFLs	26	Manual switch	No
Manu- facturing	Pin base	T8 Linear Fluoresce nt	109	Manual switch	No
Manu- facturing	Pin base	T8 Linear Fluoresce nt	8	Occu- pancy sensor	No



# C&I Halogen Penetration



For a less-common measure, the relationship changes – agreement is higher among people in the more “common” condition – not having halogens

Higher agreement among those who reported not having equipment – the more common condition.

## Respondent 1: Business Customers Phone survey instrument

- IL1. What types of hardwired overhead lighting are installed in your space? Do you have...  
[1=Yes, 2=No, 8=Don't know, 9=Refused]
- a Linear fluorescent lights
  - b Compact fluorescent lights / CFLs
  - c Incandescent bulbs
  - d Metal halide bulbs
  - e High pressure sodium bulbs
  - f Mercury vapor bulbs
  - g Halogen bulbs
  - h LED lights
  - i Neon lights (Cold Cathode)

## Respondent 2: Site Auditors Excel table on tablet

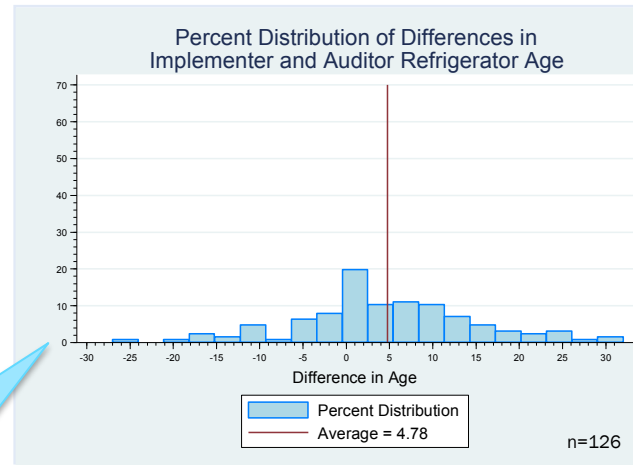
Space Type	Fixture Type	Lighting Type	Fixture Quantity	Control Type	Fixture is plugged into wall
Office	Screw base	Incan-descent Exit Signs	5	No Control	No
Office	Pin base	T8 Linear Fluoresce nt	112	Manual switch	No
Office	Screw base	CFLs	26	Manual switch	No
Manu-facturing	Pin base	T8 Linear Fluoresce nt	109	Manual switch	No
Manu-facturing	Pin base	T8 Linear Fluoresce nt	8	Occu-pancy sensor	No

# Appendix: Differences between Auditors

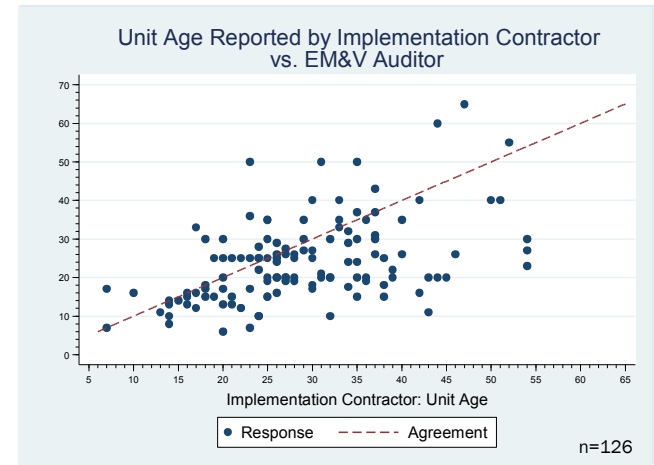
Subtitle

# Recycled Refrigerator Unit Age

Large and meaningful different in equipment age



On average, implementation contractors reported that refrigerators were 4.8 years older than EM&V auditors reported (a 35% difference!)



Pearson's r correlation = 0.48  
(Categorized as Strong positive correlation)

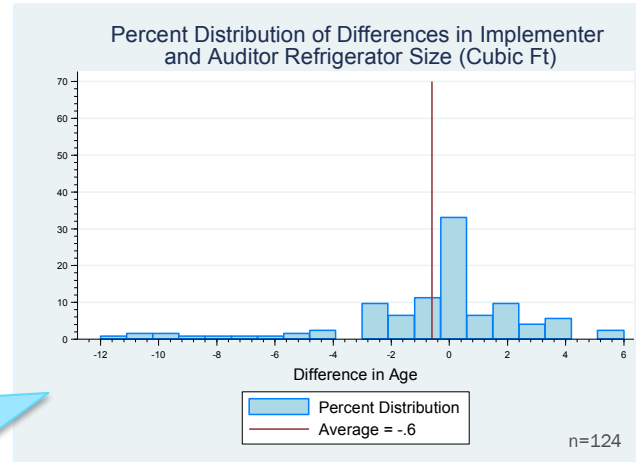
Respondent 1: Implementation Staff  
Unknown collection method

Year of manufacture, but not age, is recorded in a database. We do not know what the original data collection method was.

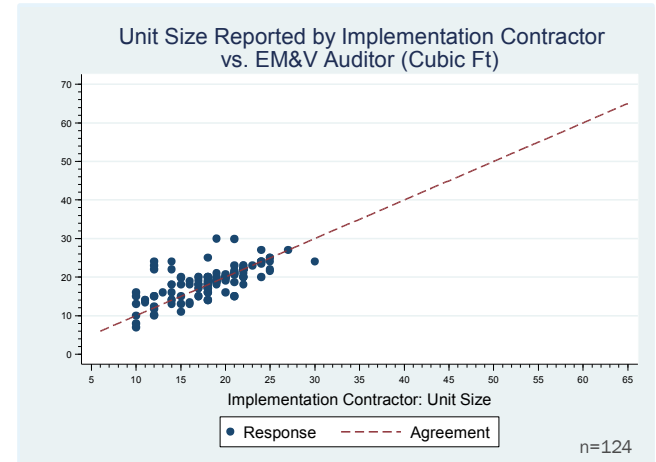
Respondent 2: Metering Study Auditors  
Recorded on paper form

Manufacturer			← write in
Model Number			← on nameplate
Manufacturing Year	year:	if no year, estimated age:	← on nameplate
Internal Capacity (Cubic Feet)			

# Recycled Refrigerator Unit Size (Cubic Feet)



On average, implementation contractors reported that refrigerators were 0.6 cubic feet smaller than EM&V auditors reported (a 1.7% difference)



Pearson's r correlation = 0.69  
(Strong positive correlation)

Small discrepancy  
in unit size

Respondent 1: Implementation Staff  
Unknown collection method

Cubic feet is recorded in a database. We do not know what the original data collection method was.

Respondent 2: Metering Study Auditors  
Recorded on paper form

Manufacturer			← write in
Model Number			← on nameplate
Manufacturing Year	year:	if no year, estimated age:	← on nameplate
Internal Capacity (Cubic Feet)			