Reasons for “Energy” Surveys

- **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

On-Site Verification (audits, metering):
- ✓ (More) accurate
- ✓ Comprehensive
- ✗ Hard to schedule
- ✗ Intrusive
- ✗ Equipment errors

Source: Mad Dash Field Services
We ask some tough questions
Thanks to much wiser contributors

Tami Buhr, Director of Survey Research

Katherine Randazzo, Director of Advanced Analytics

Zach Ross, Project Analyst

Garrick Wahlstrand, Senior Analyst
Learning from nested samples

- 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
### Residential CFL Penetration: 3 Studies

<table>
<thead>
<tr>
<th>Description</th>
<th>Study #1</th>
<th>Study #2</th>
<th>Study #3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-Report Method</strong></td>
<td>Phone Survey</td>
<td>Phone Survey</td>
<td>Mail Survey</td>
</tr>
<tr>
<td><strong>Verification Method</strong></td>
<td>Site Audit</td>
<td>Site Audit</td>
<td>Site Audit</td>
</tr>
<tr>
<td><strong>Nested n</strong></td>
<td>214</td>
<td>70</td>
<td>228</td>
</tr>
<tr>
<td><strong>Overall Agreement</strong></td>
<td>91%</td>
<td>94%</td>
<td>85%</td>
</tr>
<tr>
<td><strong>Among self-reported “Yes”</strong></td>
<td>99%</td>
<td>97%</td>
<td>88%</td>
</tr>
<tr>
<td><strong>Among self-reported “No”</strong></td>
<td>44%</td>
<td>67%</td>
<td>55%</td>
</tr>
</tbody>
</table>

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

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

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

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

Overall Agreement: 85%
Among self-reported “Yes”: 88%
Among self-reported “No”: 55%

Unweighted penetration (Auditor): 84%

n=228
Residential LED Penetration

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

Unaided (no definition)
# Commercial Lighting Penetration: 3 Types

<table>
<thead>
<tr>
<th>Description</th>
<th>CFL</th>
<th>Incandescent</th>
<th>Halogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Report Method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verification Method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nested n</td>
<td>277</td>
<td>284</td>
<td>283</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results (% Agreement)</th>
<th>CFL</th>
<th>Incandescent</th>
<th>Halogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Agreement</td>
<td>67%</td>
<td>57%</td>
<td>72%</td>
</tr>
<tr>
<td>Among customers who reported “yes”</td>
<td>77%</td>
<td>68%</td>
<td>27%</td>
</tr>
<tr>
<td>Among customers who reported “no”</td>
<td>59%</td>
<td>48%</td>
<td>81%</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Fixture Type</th>
<th>Lighting Type</th>
<th>Fixture Quantity</th>
<th>Control Type</th>
<th>Fixture is plugged into wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Screw base</td>
<td>Incandescent Exit Signs</td>
<td>5</td>
<td>No Control</td>
<td>No</td>
</tr>
<tr>
<td>Office</td>
<td>Pin base</td>
<td>T8 Linear Fluorescent</td>
<td>112</td>
<td>Manual switch</td>
<td>No</td>
</tr>
<tr>
<td>Office</td>
<td>Screw base</td>
<td>CFLs</td>
<td>26</td>
<td>Manual switch</td>
<td>No</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Pin base</td>
<td>T8 Linear Fluorescent</td>
<td>109</td>
<td>Manual switch</td>
<td>No</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Pin base</td>
<td>T8 Linear Fluorescent</td>
<td>8</td>
<td>Occupancy sensor</td>
<td>No</td>
</tr>
</tbody>
</table>

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

Did “no” mean “don’t know” for these people?
Counts
On average, customers report having 5.4 fewer CFLs than auditors found.

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

Started with quantity rather than yes/no; Respondents can say “none”
Commercial: Desktop Computer Counts

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

Respondent 1: Business Customers
Phone survey instrument

CE1Which 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]

CE2How many <CE MEASURE>s are in regular use at your facility?

Respondent 2: Site Auditors
Excel table on tablet

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Type</th>
<th>Quantity</th>
<th>Energy Star</th>
<th>Avg Screen Size</th>
<th>Screen Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>13</td>
<td>No</td>
<td>17</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>7</td>
<td>Yes</td>
<td>15</td>
<td>CRT</td>
</tr>
<tr>
<td>Office</td>
<td>Laptop computer</td>
<td>2</td>
<td>Yes</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>3</td>
<td>Yes</td>
<td>21</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>2</td>
<td>Yes</td>
<td>24</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>22</td>
<td>Yes</td>
<td>15</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>13</td>
<td>No</td>
<td>17</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>7</td>
<td>Yes</td>
<td>15</td>
<td>CRT</td>
</tr>
</tbody>
</table>

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

[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)
**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**

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Lighting Type</th>
<th>Fixture Quantity</th>
<th>Control Type</th>
<th>Hours On are Same as Business Hours</th>
<th>Hours On per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>T8 Linear Fluorescent</td>
<td>4</td>
<td>Manual switch</td>
<td>1</td>
<td>=Bus. Hrs</td>
</tr>
<tr>
<td>Office</td>
<td>CFLs</td>
<td>4</td>
<td>Manual switch</td>
<td>1</td>
<td>=Bus. Hrs</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>T8 Linear Fluorescent</td>
<td>6</td>
<td>Manual switch</td>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>T8 Linear Fluorescent</td>
<td>8</td>
<td>Occupancy sensor</td>
<td>0</td>
<td>60</td>
</tr>
</tbody>
</table>

**Respondent 2: HOBO Light Loggers**

Light on/off and occupancy sensors
Strategies for Mitigating Errors

Subtitle
Tools for mitigating errors

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

- **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**

<table>
<thead>
<tr>
<th>Day</th>
<th>Start Time</th>
<th>Stop Time</th>
<th>Open 24 Hours</th>
<th>Closed 24 Hours</th>
<th>Same as prev. day?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon</td>
<td>6:00 AM</td>
<td>4:30 PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tues</td>
<td>6:00 AM</td>
<td>4:30 PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wed</td>
<td>6:00 AM</td>
<td>4:30 PM</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Thurs</td>
<td>6:00 AM</td>
<td>4:30 PM</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Fri</td>
<td>6:00 AM</td>
<td>4:30 PM</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Sat</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Sun</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Tip 5: Clarify definitions and define unfamiliar terms

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

<table>
<thead>
<tr>
<th>Aid for some</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL1. Have you ever heard of compact fluorescent light bulbs, sometimes called CFLs?</td>
</tr>
<tr>
<td>[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.</td>
</tr>
<tr>
<td>CFL2. Do you currently have any CFLs installed inside or outside of your home?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aid for everyone</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFL1. Have you ever heard of compact fluorescent light bulbs, sometimes called CFLs?</td>
</tr>
<tr>
<td>[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)</td>
</tr>
<tr>
<td>CFL2. Do you currently have any CFLs installed inside or outside of your home?</td>
</tr>
</tbody>
</table>
Example: Clarify definitions

- 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

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

- 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

- 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

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

<table>
<thead>
<tr>
<th></th>
<th>Mail Self-Report</th>
<th>On-Site Audit Findings</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n$</td>
<td>180</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>Have LEDs</td>
<td>34%</td>
<td>6%</td>
<td>= 6%/34% = 0.17</td>
</tr>
<tr>
<td>Do Not have LEDs</td>
<td>66%</td>
<td>94%</td>
<td>= 94%/66% = 1.44</td>
</tr>
</tbody>
</table>
Adjustment Ratio Example: Step 3

- Apply ratios to entire sample of mail survey responses:

<table>
<thead>
<tr>
<th></th>
<th>Mail Self-Report</th>
<th>Adjustment Factor</th>
<th>Adjusted n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have LEDs (n)</td>
<td>1,600</td>
<td>0.17</td>
<td>= 1600 * .17 = 272</td>
</tr>
<tr>
<td>Do Not have LEDs (n)</td>
<td>2,500</td>
<td>1.44</td>
<td>= 2500 * 1.44 = 3,600</td>
</tr>
</tbody>
</table>

Adjusted Penetration = 272/ (272+3600) = 7%

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

Amanda Dwelley
Associate Director
617-301-4629
adwelley@opiniondynamics.com

Visit us at 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

- 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

- 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”)

<table>
<thead>
<tr>
<th>Room</th>
<th>A Resistance / Baseboard Heaters</th>
<th>B Heat Pump</th>
<th>C Portable Space Heaters</th>
<th>D Other Electric Heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedroom</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Bathroom</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Kitchen</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Living/Family Room</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Den/Office</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Dining Room</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Finished Basement</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Not used</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

- 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

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

### 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”**

<table>
<thead>
<tr>
<th>Room</th>
<th>A Resistance / Baseboard Heaters</th>
<th>B Heat Pump</th>
<th>C Portable Space Heaters</th>
<th>D Other Electric Heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedroom</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Bathroom</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Kitchen</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Living/Family Room</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Den/Office</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Dining Room</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Finished Basement</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Not used</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

This row means something different (not the same as other categories) – needs to be separated out in some way.
Appendix: Counts
Residential: Desktop Computer Counts

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

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

Respondent 1: Residential Customers
Mail Survey Instrument

Respondent 2: Site Auditors
Survey instrument on tablet PC

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

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

Respondent 1: Residential Customers
Mail Survey Instrument

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

<table>
<thead>
<tr>
<th>None</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Cable/satellite box with DVR (digital video recorder)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b. Stand-alone cable/satellite box</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c. Stand-alone DVR (e.g., TiVo)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>d. Video game player</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>e. Laptop/Tablet</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>f. Desktop Computer</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

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

Identifying and Mitigating Common Self-Reporting Errors in Energy Surveys
Respondent 1: Residential Customers
Mail Survey Instrument

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

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]

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

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

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Type</th>
<th>Quantity</th>
<th>Energy Star</th>
<th>Avg Screen Size</th>
<th>Screen Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>13</td>
<td>No</td>
<td>17</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>7</td>
<td>Yes</td>
<td>15</td>
<td>CRT</td>
</tr>
<tr>
<td>Office</td>
<td>Laptop computer</td>
<td>2</td>
<td>Yes</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>3</td>
<td>Yes</td>
<td>21</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>2</td>
<td>Yes</td>
<td>24</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>22</td>
<td>Yes</td>
<td>15</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>13</td>
<td>No</td>
<td>17</td>
<td>Flat screen</td>
</tr>
<tr>
<td>Office</td>
<td>Desktop computer</td>
<td>7</td>
<td>Yes</td>
<td>15</td>
<td>CRT</td>
</tr>
</tbody>
</table>

Distribution of Differences in Self-Reported and Audited Quantities for Laptop Computers

On average, customers reporting having 5.7 fewer laptop computers than auditors found
Lighting Hours-of-Use adjustment to self-reported data

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

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Logger n</th>
<th>Hrs/Week reported to Auditor (Wgtd Avg)</th>
<th>Hrs/Week observed with loggers (Wgtd Avg)</th>
<th>Adjustment Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>office</td>
<td>118</td>
<td>56.2</td>
<td>45.7</td>
<td>81%</td>
</tr>
<tr>
<td>conference room or classroom</td>
<td>22</td>
<td>41.6</td>
<td>36.2</td>
<td>87%</td>
</tr>
<tr>
<td>dining area (+food prep)</td>
<td>37</td>
<td>60.4</td>
<td>58.5</td>
<td>97%</td>
</tr>
<tr>
<td>hallway/stairwell (+other/all spaces + lobby/atrium)</td>
<td>34</td>
<td>87.5</td>
<td>73.1</td>
<td>84%</td>
</tr>
<tr>
<td>storage areas (+fridge storage)</td>
<td>38</td>
<td>61.7</td>
<td>56.3</td>
<td>91%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>249</strong></td>
<td><strong>64.5</strong></td>
<td><strong>55.9</strong></td>
<td><strong>87%</strong></td>
</tr>
</tbody>
</table>
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 require unaided awareness, but concept is fairly well-known.

Overall Agreement: 58%
Among self-reported “Yes”: 50%
Among self-reported “No”: 86%

Count of Customers Reporting Primary Refrigerator is ENERGY STAR

<table>
<thead>
<tr>
<th></th>
<th>Reported Having</th>
<th>Reported Not Having</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eqpt Found</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eqpt Not Found</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eqpt Found</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eqpt Not Found</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

n=128
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

Respondent 2: Site Auditors
Survey instrument on tablet PC

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

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

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

Overall Agreement: 62%
Among self-reported “Yes”: 60%
Among self-reported “No”: 79%
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
[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

[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

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

Aided awareness technique – Description of what it looks like

Asked of Aware Only

Overall Agreement: 91%
Among self-reported “Yes”: 99%
Among self-reported “No”: 44%
## 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**

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Fixture Type</th>
<th>Lighting Type</th>
<th>Quantity</th>
<th>Control Type</th>
<th>Fixture is plugged into wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Screw base</td>
<td>Incandescent Exit Signs</td>
<td>6</td>
<td>No Control</td>
<td>No</td>
</tr>
<tr>
<td>Office</td>
<td>Pin base</td>
<td>T8 Linear Fluorescent</td>
<td>112</td>
<td>Manual switch</td>
<td>No</td>
</tr>
<tr>
<td>Office</td>
<td>Screw base</td>
<td>CFLs</td>
<td>26</td>
<td>Manual switch</td>
<td>No</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Pin base</td>
<td>T8 Linear Fluorescent</td>
<td>109</td>
<td>Manual switch</td>
<td>No</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Pin base</td>
<td>T8 Linear Fluorescent</td>
<td>8</td>
<td>Occupancy sensor</td>
<td>No</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Space Type</th>
<th>Fixture Type</th>
<th>Lighting Type</th>
<th>Fixture Quantity</th>
<th>Control Type</th>
<th>Fixture is plugged into wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>Screw base</td>
<td>Incandescent Exit Signs</td>
<td>5</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Office</td>
<td>Pin base</td>
<td>T8 Linear Fluorescent</td>
<td>112</td>
<td>Manual switch</td>
<td>No</td>
</tr>
<tr>
<td>Office</td>
<td>Screw base</td>
<td>CFLs</td>
<td>26</td>
<td>Manual switch</td>
<td>No</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Pin base</td>
<td>T8 Linear Fluorescent</td>
<td>109</td>
<td>Manual switch</td>
<td>No</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Pin base</td>
<td>T8 Linear Fluorescent</td>
<td>8</td>
<td>Occupancy sensor</td>
<td>No</td>
</tr>
</tbody>
</table>
Appendix: Differences between Auditors

Subtitle
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)

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

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>write in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Number</td>
<td>on nameplate</td>
</tr>
<tr>
<td>Manufacturing Year</td>
<td>year: if no year, estimated age: on nameplate</td>
</tr>
<tr>
<td>Internal Capacity (Cubic Feet)</td>
<td></td>
</tr>
</tbody>
</table>