Measuring the Success of CFL Energy Efficiency Programs

It's The Saturation, Stupid

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Abstract

Measuring market change in saturation can provide an indicator of the actual usage of the targeted products. Specifically, collecting saturation can be valuable because:

- Sales data are not always available, and can be a costly process to obtain.
- Data on the number of bulbs sold per transaction are not available, but saturation provides an indication of the numbers of bulbs customers are purchasing.
- Only saturation can provide information on whether bulbs are ending up in a greater number of homes.
- Saturation can account for leakage into or out of an area.
- Saturation also takes into account persistence due to either negative perceptions of the lighting, and/or quality issues, which may require an early replacement of a bulb.
- Saturation can also provide insight on the replacement of CFLs with other CFLs, which is difficult for users to recall.

When collected through in-home visits, saturation can provide even more insight on the potential of the lighting market. While data may be available from telephone surveys with CFL purchasers, the data are not reliable due to self-reporting issues. Databases of programs offering rebate coupons, although they provide valuable information for participants in the program, do not offer sufficient insight into the wider market.

Why collect saturation data? How difficult is it to measure lighting saturation? What sample sizes are needed? Can saturation reliably track market changes over time? Can we use saturation as a metric for assessing program effectiveness? Our research explores these issues.

Introduction and Methodology

We define saturation of energy efficient light bulbs as the percentage of lighting sockets in the average home that are filled with compact fluorescent lighting (CFLs).[1] One major reason for measuring market change in saturation is that it provides a good indicator of the actual usage of targeted CFLs. Over the past two years, our evaluation team conducted 200 in-home visits in Massachusetts and 59 in-home visits in Connecticut, for a total of 259 in-home visits. The goal of these site visits over the two-year period was to collect data on CFL penetration, saturation, and information on barriers to installing additional CFLs. (See Table 1.)

[1] Note that another term that we use throughout this paper is penetration, which is the number of homes that have at least one CFL installed.

Table 1. Lighting In-Home Visits In Massachusetts and Connecticut

Evaluation Research	Number of In-Home Visits Completed	Goals
2003 Massachusetts Evaluation	100 randomly selected homes, and 50 program participant homes	Penetration; Saturation; Barriers; Differences Between Participants and general Pop
2004 Massachusetts Evaluation	50 homes	Accuracy of telephone interview Self-Reported information
2004 Connecticut Evaluation	59 homes	Penetration; Saturation; Barriers; Accuracy of Self-Reports
Total	259	

In our 2004 efforts, we also specifically focused on understanding the accuracy of telephone survey answers regarding CFLs installed in homes so that we could assess the relative merits of collecting data via telephone compared to collecting data through in-home visits. The distribution of the site visits in 2004 was specifically chosen to get a full range in the CFL counts to allow us to compare telephone self-reported data to in-home visits for a wide range of CFL counts.[2]

The pre-screen telephone survey described CFLs and also stated what they are not (e.g., Watt Miser and standard fluorescents). It then asked respondents how many CFLs they had installed inside their home.

While on-site, auditors collected data on all sockets in the home, including location, fixture type, number of sockets per fixture, socket type and bulb type and shape. ODC site auditors collected information on a hand-held personal digital assistant (PDA) using ODC's customized EEsiteAuditor program. This method of data collection allowed for consistent reporting of data and eliminated the need for post-visit data entry.

Why Saturation

Over the past few years, utilities and regional working groups have tried to gather sales data for compact fluorescent light bulbs with mixed success. Obtaining sales data has proven to be both costly and elusive. Tracking sales by collecting actual sales data from a sample of participating retailers and extrapolating to the population of all participating retailers, as well as using telephone surveys with non-participating retailers, have been used to evaluate market transformation programs and determine program net effects. These methods are not expensive and are important contributors to the effort. However, due to data issues, the reliability of the findings may be compromised and may unwittingly introduce bias within the final usage of these data. If sales data for CFLs were available, it is doubtful that it would be available for all retailer types and for all manufacturers—in fact, the current work to develop sales data for CFLs is focused on retailer data that only includes the larger national and retailer chains. Furthermore, retailers are unlikely to divulge the entirety of their sales data of lighting, including non-CFL bulbs sales. It is difficult to understand the full meaning of CFL sales data unless it is placed in the context of all light bulb sales (which would be an even more Herculean effort).

[2] In-home visit participants were sampled throughout Connecticut, with most of them being conducted in the three most populous counties in the state. Respondents were asked to report the number of CFLs installed in their home when they were being recruited to participate in an on-site visit.

It is important to note that saturation is better suited for measuring market transformation effects rather than resource acquisition. The cumulative and combined effects of CFL sales (without regard to whether they were acquired through a program or not), including burn-outs, replacements, and leakages, may not be able to be separately studied but together can make an indicator for the market as saturation levels change over time. Analysis of program databases can show the level of resource acquisition in a certain area, but on-site saturation studies are especially valuable in areas where there are no programs offering rebate coupons and no program databases to analyze—such as in areas where programs have moved to buy down efforts and have eliminated rebate coupons. In 2004, we conducted research to examine possible ways of collecting saturation data. This research led to support from program administrators and Saturation, or the percentage of all sockets filled with CFLs, offers an alternative metric for gauging changes in the lighting market over time.

Saturation can provide information on the number of bulbs purchased (or more specifically in use) per customer. Without detailed sales data, including data on the number of bulbs purchased per transaction, we do not know whether bulbs are being purchased by individual consumers, or perhaps by contractors (purchasing in bulk) for use in new homes. Transactional data, however, has proven difficult to collect from a large number of stores.

Moreover, only saturation information provides us with details on whether CFL sales are leading to an increase in the number of CFL users, or alternatively an increase in the number of CFLs among past users. While some regional efforts have tried to assess these issues through the use of telephone interviews, our findings (shown throughout this paper) suggest major limitations in collecting this type of data via telephone.

CFLs are unlike any other energy efficient home product because they are small, mobile and do not cost a lot. As such, they can easily be moved or replaced. Another benefit of determining saturation is that, when comparing to lighting sales, saturation can help account for bulbs consumers purchase for use in non-program areas.

Saturation also takes into account persistence due to either negative perceptions of the lighting, and/or quality issues, which may require an early replacement of a bulb. Moreover, it is one of the easiest ways to get a sense of the amount of replacement of CFLs by CFLs, and the extent to which CFLs are being used, or placed into storage.

In summary, on-site saturation surveys offer a good metric for tracking program changes over time because it also helps provide insight into the following key issues:

- It can serve as a proxy for sales data
- It helps to provide data on the number of bulbs sold per transaction
- It provides data on where bulbs are installed
- It provides information on leakage into or out of an area
- It provides guidance on persistence due to either negative perceptions and/or quality issues

It provides insight on the replacement of CFLs with other CFLs[3] interveners for using saturation as a measurable program metric. Our research in this area is presented below.

[3] Future evaluations should consider studying CFLs that are not immediately put into use but are purchased with the intent to install later.

Assessing Saturation

It is difficult to collect information on the efficiency of many lighting and appliance measures because it requires that the consumer is either aware of the efficiency of the measure, or is able to check the labels/coding of the product. However, it is particularly difficult in the case of lighting given the number of lights in a home. While saturation of energy efficient washing machines, for example, requires only that we know whether the home has a washer and the efficiency of that particular washer, the average home has around 50 lighting sockets and saturation of energy efficient lighting requires understanding the total number of lighting sockets in a home, as well as the efficiency of each bulb.

Asking consumers to accurately report on the number of lighting sockets in their home is not practical (and extremely time consuming). While an assessment of saturation could use an average count of the number of lighting sockets in a home, our data suggest that there is a large variation in the number of sockets per home. Our Massachusetts-based in-home site visits in 2003 (conducted with 100 randomly selected homes) found an average of 52 sockets in the random sample with a standard deviation of 35.7. This makes it difficult to use an average socket count to assess saturation via the telephone. Furthermore, our research suggests that even asking consumers to report on the number of CFLs in their home may be difficult. (See next section.)

Reported Versus Actual CFL Counts

One of the tasks of our research was to conduct a direct comparison between self-reported CFL counts (via telephone survey) and actual usage of CFLs found through in-home visits to these same homes.[4] Our research found that consumers are not able to accurately report the number of CFLs in their homes. Moreover, a large percentage of consumers are not even able to accurately report whether they are using CFLs or not.

Accuracy of Individual Reports

In 2004, the average number of CFLs reported by the in-home visit sample in Massachusetts was 2.6. The number of CFLs found in the in-home visits averaged 3.7 for the interior of the home and an average of 4.5 total CFLs to include the interior and exterior sockets. (Our Connecticut findings were similar.) This under-reporting means that the telephone survey provides a biased estimate of the number of CFLs per home, a 30% downward bias ([2.6/3.7]-1). The site auditors suggested from their experience that part of the under-reporting of CFLs could be attributed to consumers associating a fixture as having one CFL without realizing that many fixtures have multiple sockets.

There is not, however, a universal under-reporting as might be imagined based on the information above. Table 2 presents the actual, reported, and difference between the reported and actual for all respondents. The table is sorted by the difference so the reader can see the number of over-reports and the number of under-reports. Comparing the telephone survey responses to the site visit findings for *interior only* CFL counts showed that there are 12 respondents (24%) that accurately report how many CFLs they have interior to their homes. Twenty-five respondents (or 50%) under-reported and 13 (26%) over-reported the number of CFLs in their home. The range for this under and over reporting was from 17 under-reported to 10 over-reported for a sample of 50 sites.

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[4] Note that we discuss the biases of telephone surveys in the aggregate below.

Table 2. Massachusetts Reported versus Actual Total CFL Counts (Interior)

Δ (= Actual – Report)		Frequency
17	**UNDER REPORTS (25 total)**	1
11		1
10		2
9		1
7		3
6		2
4		6
3		3
2		4
1		2
0	**ACCURATE REPORTS (12 total)**	13
-1	**OVER REPORTS (13 total)**	2
-2		5
-3		2
-4		2
-5		1
-10		1

We also looked to see how many of the telephone survey quantities were within one or two of the actual count found. The exact accuracy (reported above) was 26%. Those within plus or minus one of the actual number of interior CFLs found raises the "on-target" figure up to 36%. Being even more generous and allowing a plus or minus two brings those within this range at 60%. That still means that 40% of respondents were not within plus or minus two in their estimate of how many CFLs they have in their home. Furthermore, the 60% that are within plus or minus two means that it is only somewhat better than a coin toss that any specific household estimate will be within plus or minus two CFLs (which is itself 50% of the mean).[5]

We can conclude, therefore, that consumers are not able to accurately report how many CFLs they have in their homes. Only 26% of those visited accurately estimated how many CFLs they had in their home when asked on the telephone.[6] A much more generous target of being within plus or minus two CFLs still found that only 60% of respondents were within this target. This means that 40% of respondents were not within plus or minus two in their estimate of how many CFLs they have in their home. Moreover, even in the aggregate, there is a bias in telephone results. Below we discuss methods for accounting for this bias in future efforts.

Respondents Who Stated That They Have Zero CFLs

Before our research commenced, there was a hypothesis that consumers might be accurate in at least being able to tell us whether they have any CFLs in their home. In other words, that a telephone

[5] Two CFLs may not sound like a lot. Yet, the average number of interior CFLs found in the site visits is less than four (3.74). If a household has the average number of CFLs and average number of interior sockets, their saturation is 7.6% (= 3.74/49). If, on average, consumers added two CFLs to their home their saturation rises to 11.7% (= 5.74/49), a very significant increase. An error in their reporting by telephone of two CFLs can have a large impact on their saturation estimate.

[6] This is based only on interior sockets.

survey report of "zero CFLs installed" would be accurate. Since we could then tell the percentage of homes with zero CFL's, we could weight our overall findings and we would not need to visit any homes that reported having zero CFLs. This would reduce the sample sizes necessary for conducting in-home visits—a savings for utility sponsors and evaluators. Unfortunately, we found that of those that reported having no CFLs, only half were accurate. The other half of these respondents did have CFLs.[7]

Our sample design in Massachusetts was heavily weighted toward those respondents that said they had no CFLs (22 of the 50 sites, 44%) because the 2003 findings suggested that our assumption that consumers could accurately report whether they were using CFLs (i.e., penetration of CFLs) might not be true. The 2004 work included a significant proportion of households where respondents said they had zero CFLs to explicitly test this assumption.

There were 22 respondents in the site visit sample that stated that they had zero CFLs in their home. Eleven (11) of these, or 50%, actually had zero CFLs.[8]

There were some that reported zero CFLs that had several; including several cases where up to four (4) CFLs were found being used in that household.

Notably, there were some households in both Massachusetts (6) and in Connecticut (6) where many CFLs were reported but none were found (including one case where 10 were reported and none found).[9]

As such, we conclude that consumers are not always familiar enough with CFLs to self-report data on whether they are using CFLs in their homes. Anecdotally, it appeared that many consumers were confusing CFLs with other lighting. Alternatively, some users may not be aware that they are using CFLs if a previous occupant, or a family member/roommate installed the lighting.

These findings indicate that telephone or self-reported surveys (at least in areas with similar levels of awareness of CFLs) do not provide accurate reporting on whether consumers are using CFLs or not.

Variance of Data

Figure 1 provides a graphic display of the quantity of CFLs reported over the telephone compared to that found when the site was visited. The variance goes up as more CFLs are reported. Yet, given a reporting of zero can only have unidirectional variance this increasing variance is not surprising. Additionally, it is easy to imagine that it is harder for someone to know if they have four CFLs versus six CFLs among their approximately 50 sockets than if they have any at all. In the next section, we examine our results (in the aggregate) to give insights into the best methods for measuring saturation and penetration in future efforts.

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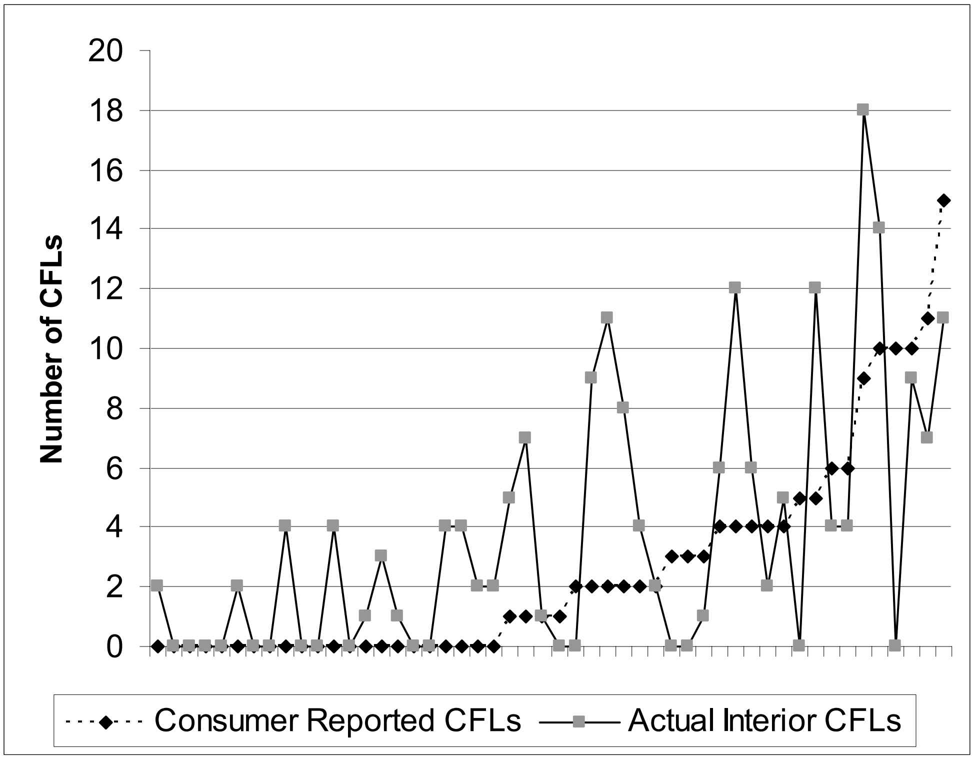
[7] Equally troubling is the finding that six of those that said they had CFLs in their home were found not to have any by the site visit.

[8] In addition, 46% of those that over reported (six out of 13) said they had CFLs that were found not to have any CFLs during the site visit. The fact that our sample design included 22 respondents that stated that they had no CFLs also means that the only way a misreporting could occur for this large proportion of the sample is for an under-reporting (i.e., we could not have found less than zero on these sites). This may be one of the reasons we see far more under-reporting than over-reporting (in the table above).

[9] In some instances, customers may have confused CFLs with standard fluorescent lighting, despite being read a description that specifically pointed out the difference between the two.

Figure 1. Reported versus Actual Interior CFL Counts



Bias and the Use of Telephone Surveys to Estimate Changes in Saturation

A telephone survey instrument can be inaccurate but unbiased: as long as the sample is quite large, the over-estimates and under-estimates balance each other out. However, if there is a bias then no matter how great the sample size, the overall sample average will not be the same as the true answer. When we examined our data in the aggregate, we found both inaccuracies in reporting, and biased results (as well as a selection bias issue that is yet unmeasured). Below we discuss the implications of these findings, and what evaluators would need to do to adjust for these biases.

Due to the large standard deviation in the amount of error for the telephone survey responses, determining a factor (at 90% confidence ±20% error) to adjust for inaccuracies in telephone surveys would require 800 telephone interviews and 800 in-home visits to the same homes. Determining this factor, therefore, would be costly, but it *would* allow evaluators to rely exclusively on telephone interviews in future years (approximately 500 interviews per year) for as long as this factor is considered to be representative of the bias.[10]

However, even if respondents were accurate in their estimation of the number of CFLs per home, estimating saturation would require dividing the average number of CFLs by an average socket count. As mentioned above, our findings suggest that there is a large variation in the number of sockets per home. Our in-home site visits in 2003 (conducted with 100 randomly selected homes) found an average

[10] Given the fact that a program will most likely be working to increase awareness and understanding of CFLs, the adjustment factor (which adjusts for the fact that many customers inaccurately report both whether they have CFLs and the number of CFLs) would need to be updated periodically.

of 52 sockets in the random sample with a standard deviation of 35.7. This again, is another reason why telephone surveys may not be the most accurate estimation of changes in saturation.

Estimating Saturation Through In-Home Visits

Saturation, collected by in-home visits, can account for the fact that consumers are not always familiar enough with CFLs to self-report data on whether they are using CFLs. It can allow for an accurate collection of the number of sockets per home, as well as additional insights on the potential of the market.

Given the above findings about the biases of telephone reporting (and the cost of correcting for this bias), it appears that periodic in-home visits are the preferable method for which to measure saturation and the change in saturation. A random in-home visit can allow evaluators to count CFLs at all homes whether or not the consumer is familiar with a CFL. But how many visits would be needed to accurately report on changes in saturation?

Based on the data that we collected, evaluators would need to conduct approximately 350 in-home visits as a base, and 350 each additional period to determine penetration (at 90% confidence ±10% error), and the average number of CFLs per home (at 90% confidence ±10% error). This would also allow evaluators to determine the change in saturation over time at greater than 90% confidence ±50% error, which appears to be a viable option given the growth rates expected.

Note that in addition to the two methods above, we also explored whether a split-sample approach—which would split the sample into respondents who claim to have zero (or are not familiar with CFLs) and respondents who claim to have at least one CFL—might provide a more cost-effective approach. Originally there was an assumption that though people might be inaccurate in being able to say *how many* CFLs they have, given the average Massachusetts single family home has 49 interior sockets, there was some thought that respondents could accurately identify if they had zero CFLs. As mentioned earlier, half of the respondents in the site visit sample who stated they had zero CFLs actually had no CFLs.[11] (However, this is still much better than the fact that **none** of those reporting three or more CFLs were accurate on the exact number of CFLs they had in their home.)

It was suggested that the possibility of using the opposite split-sample approach be examined. This would be to use the telephone survey for those that reported having at least one CFL and conducting in-home visits for those reporting zero CFLs or saying they are not familiar with CFLs. If those reporting have at least one CFL provides an estimate of the average number of CFLs for these types of homes very close to the actual number, then this would be an unbiased estimate and would need no adjustment factor. Unfortunately, however, the telephone survey estimate from this subset still provides a biased estimate of the average number of CFLs for these types of homes. The average number of CFLs reported by the telephone survey sample for those reporting at least one CFL was 4.7 while the in-home visits found 5.6 CFLs per home for these homes.

Our analysis found a large standard deviation on the error between the telephone survey reported number of CFLs and the number found during the in-home visit. This means that using this split-sample approach to achieve 90% confidence and ±10% error is most likely cost prohibitive. Even at a statistical significance of 90% confidence ±20% error, evaluators would need almost 2,000 telephone interviews and 2,000 in-home visits to get the instrument error adjustment for respondents who claim to have at least one CFL. In addition, they would also need 150 telephone screens and 150 in-home visits to those unfamiliar with CFLs or reporting "0" CFLs in their home. Thus, with a total of 2,150 surveys and the

[11] In addition, 46% of those that over reported (six out of 13) said they had CFLs that were found not to have any CFLs during the site visit.

same number of site visits, it would be even more costly to complete a hybrid approach to achieve the same significance (90% confidence ±20%) for the bias adjustment factor as 800 telephone surveys and 800 in-home visits for this factor in the telephone survey approach.

We have presented Table 3 with possible options for measuring progress in lighting programs in the future. Evaluators may wish to choose one of these depending on the desired indicators/outcome, the need for overall precision, and the available budget. Obviously costs play a role in determining the most appropriate methodology. In-home visits, although they undeniably are the most accurate, are more expensive than telephone surveys. Evaluators may wish to choose either lower precision requirements or to obtain estimates that are imprecise and used only as more qualitative indicators rather than precise impact-type estimates.

Table 3. Summary Table of Sample Size Requirements, Issues, and Examples

Method		**Penetration and/or Average # of CFLs per Home***		**Saturation Estimate (#CFLs/#sockets)**		**Change in Saturation (Difference from two surveys over time.)**	
In-Home Visits	**Statistical significance:**	90/10	90/20	90/10	90/20	90/10	90/50
	Sample size:	Under 400	100	350	<100	> 1,500	300 base and 300 each following time period
	Notes:	For example, in 2003 with a sample size of 100 the average number of CFLs per home at 90% CI was 2.6 to 4.6.		For example, in 2003 the saturation estimate at 90% CI was 4.9% to 8.9% (from a sample size of 100).		NA for 2003 due to small sample size. But with 300 per yr: If see increase from 7% to 9% (2% growth) 90% confident growth would be from 1% to 3%.	
Telephone Surveys (With a periodic comparison study of telephone and in-home visit follow-ups to create adjustment factor)	**Statistical significance:**	90/10	90/20	All of the issues and sample requirements as # CFLs PLUS need to do the same for # of sockets (sampling error, instrument error & est. of adjustment factor, and check for selection bias).		Same as with saturation plus accepting 90/50 (as shown above with in-home) or increased sample sizes for change in saturation.	
	Sample size:	>3,000 telephone and >3,000 in-home to get instrument error adjustment	800 telephone and 800 in-home to get adjustment				
	Issues:	Above needed at least once (periodically) to get precision on instrument error adjustment. Then 500 telephone surveys may be used on regular basis. BUT still need study & correction for selection bias.					

* Determining the change in average number of sockets (over a one to three year period) would require additional surveys/in-home visits since the probability for error increases—most likely on the order of magnitude as determining the change in saturation.

Additional Benefits of Collecting Saturation Data Through In-Home Visits

Collecting saturation through in-home visits can also provide additional information on the market, such as what applications are being used most, what applications could be used more—hard-to-reach sockets, etc. For an example, see Table 4.

Table 4. Locations of CFLs, and Saturation by Room Type^

	Percentage of CFLs by Room Type	Percentage of sockets in room type filled with CFLs
Bedroom	18%	8%
Living room/family room	17%	8%
Kitchen	17%	9%
Basement	11%	6%
Other	9%	DNC
Hallway/stair	9%	DNC
Exterior	6%	7%
Bathroom	5%	3%
Office	3%	8%
Dining room	3%	3%
Garage	2%	DNC

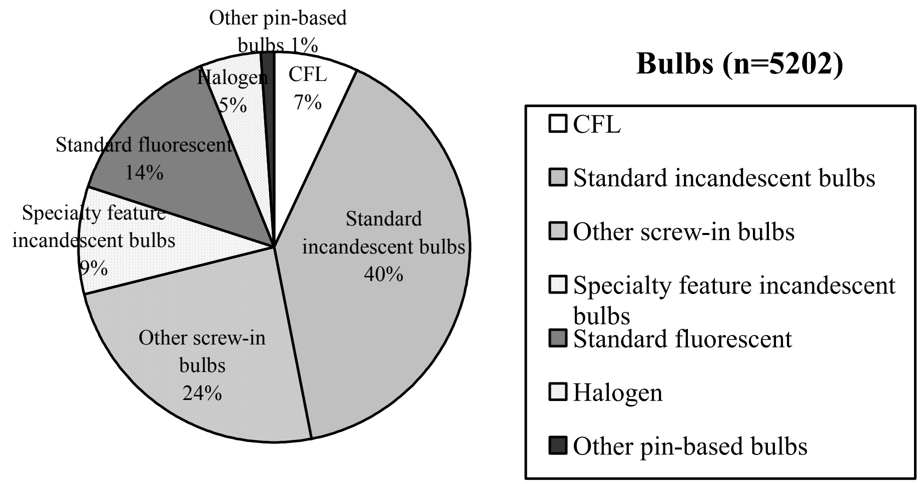
^ These percentages are from ODC's 2003-2004 inventory of CFLs in 100 randomly selected Massachusetts homes. DNC= Did not calculate.

Furthermore, by collecting data on all sockets in the home, including location, fixture type, number of sockets per fixture, socket type and bulb type and shape, we can better understand the overall potential of the market. Based on the 100 random visits in Massachusetts, we found that 7% of all sockets are filled with CFLs, which means that there is a substantial opportunity to further impact the residential lighting market. Aside from the 7% of sockets where CFLs are currently installed, more than one-half of sockets that currently use a non-efficient bulb are prime for conversion, since they are simple bulb retrofits.[12] Forty percent of all sockets have a standard-shape, standard-size, A-type incandescent bulb, for which there are numerous CFL alternatives. This 40% represents the easiest potential conversions. Other screw-based bulbs without any special features such as frosted or clear bulbs represent an additional 24% of all sockets and may also be easily replaced given the large selection of bulb shapes and types currently offered by CFL manufacturers.[13]

12 Note, however, that this does not take into account hours of use among these bulbs; customers may determine that it is not cost effective to retrofit bulbs that are used infrequently.

13 The two red areas in the figure represent these easy screw-in bulb retrofits. While this estimate takes size and shape of the bulb into account (odd sizes or shapes for which there were not alternatives were deemed "ineligible" for CFL replacement); we did not look at illumination or availability to the customer. It is possible, therefore, that the customer may not be able to find a bulb as bright as they want and/or may not know where to purchase the correct CFL replacement. Thus, this figure should be seen as an upper limit.

Figure 2. The Overall Market For Energy Efficient Bulbs In Massachusetts
(Based on 100 Random Visits Conducted in 2003)



Our data also allow us to see that these findings vary by room type (not shown in the figures or tables). For example, in Massachusetts, dining rooms have a much higher percentage of sockets (30) that are ineligible due to specialty features; while 59% of sockets in basements are standard fluorescent. These variations mean that the potential for CFL retrofits is much smaller in these two room types.

Overall, therefore, 64% of all sockets in Massachusetts can be retrofitted through bulb changes. This does not take into account hours of use for the various applications, so all applications may not be cost-effective. Additional site visits and information on hours of use of the various types of bulbs, by room type, will further the understanding of this market and will allow us to determine the percentage of bulbs that would be cost-effective to replace. As such, the data that we discuss in this paper are even more valuable if they can be placed in the context of energy usage data collected through a light logger study. This would allow evaluators to really understand what marketing messages to use, and what their ultimate program goals should be.

Summary

This work has generated important discussions concerning the ultimate program goals and how to achieve those as the market matures. This research can impact how programs of this nature are assessed, and can help to eliminate the need for spending large amounts of dollars on attempting to collect rather unreliable sales data. It also links well with program theory and program refinements as the CFL market matures, helping to better define the ultimate goals in terms of CFL usage as part of total residential lighting usage.

In summary, collecting saturation can be valuable because:

1. Sales data are not always available, and can be a costly process, and saturation offers an alternative metric.
2. Data on the number of bulbs sold per transaction are not available, but saturation can provide an indication of whether customers are purchasing a number of bulbs.

3. Only saturation can provide information on whether bulbs are ending up in a greater number of homes (versus just increasing the number of bulbs in current CFL use homes).
4. Saturation can account for leakage into or out of an area (since sales data only offer insight into a specific geographical area).
5. Saturation also takes into account persistence due to either negative perceptions of the lighting, and/or quality issues, which may require an early replacement of a bulb.
6. Saturation (collected at various time periods) can also provide insight on the replacement of CFLs with other CFLs, which is difficult for users to recall.

In addition, saturation collected by in-home visits, is also valuable because:

7. Saturation (collected by in-home visits) can account for the fact that consumers are not always familiar enough with CFLs to self-report data on whether they are using CFLs.
8. Saturation (collected by in-home visits) can account for the fact that consumers are not accurate in their reporting of the number of CFLs in their homes.
9. Saturation (collected by in-home visits) can also provide context to findings about sales by giving an indication of the total number of sockets, and socket eligibility for CFLs or the potential of the market. Even if we have sales information, in-home data provide us marketing clues (i.e. where CFLs are located, what applications are being used most, what applications could be used more—hard-to-reach sockets, etc).

But as mentioned above, these data are even more valuable if they can be placed in the context of energy usage data collected through a light logger study.

Telephone interviews with customers provide important insight into why consumers purchase (or do not purchase) CFLs, while on-site studies point to what consumers are actually using and installing in their homes. This method of measuring saturation is more cost-effective, dependable, and available than relying on CFL sales data (which may not always be available from every store) or program databases (which do not include sales of CFLs not covered by a coupon). They provide real-time information about the actual use and installation of CFLs. Tracking this over time, then, would be an indicator of market transformation.

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