Nexus Market Research, Inc.

Impact Evaluation of the Massachusetts, Rhode Island, and Vermont 2003 Residential Lighting Programs

Submitted to:

The Cape Light Compact
State of Vermont Public Service Department for Efficiency Vermont
National Grid (Massachusetts Electric, Nantucket Electric, and Narragansett Electric)
Northeast Utilities (Western Massachusetts Electric)
NSTAR Electric
Unitil Energy Systems, Inc. (Fitchburg Gas and Electric)

Submitted by:

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October 1, 2004
FINAL

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1. Executive Summary

This is a summary of an impact evaluation study of coupon and catalog sales from the 2003 Residential Lighting Programs (RLPs) in Massachusetts, Rhode Island, and Vermont, sponsored by the Cape Light Compact, Vermont Department of Public Service for Efficiency Vermont[1], National Grid (Massachusetts Electric, Nantucket Electric, and Narragansett Electric), Northeast Utilities (Western Massachusetts Electric), NSTAR Electric, and Unitil Energy Systems, Inc. (Fitchburg Gas and Electric)—the "Sponsors."

The Sponsors independently administer their own RLPs, while generally sharing a common market-based approach to encourage customers to purchase energy-efficient lighting products. The 2003 RLPs offered instant rebate coupons redeemable at local retailers and sold products at discounted prices through catalogs. Sponsors in Massachusetts and Rhode Island, but not Vermont, also administered a third approach to encourage the use of energy efficient lighting through Invitation to Participate (ITP) program sales, which are negotiated buy-down promotions with manufacturers and retailers of selected ENERGY STAR-qualifying lighting products at local retailers. This evaluation focuses only on sales of lighting products sold through the instant rebate coupon and catalog components; ITP sales were not evaluated. However, this report does include estimated impacts for the ITP purchases based on upon the input parameters as calculated at the time of the on-sites.

In this evaluation, lighting products sold through the program are categorized by four technology types: CFL bulbs (including replacement bulbs), interior fixtures (including portable table and floor lamps), exterior fixtures, and torchieres.

The findings from this evaluation are based on data collected through a variety of research activities, including:

- Telephone survey among 823 customers who participated in the 2003 RLP through instant coupon purchases from local retailers or catalog purchases.
- On-site surveys at 128 sites using lighting loggers at the homes of participating customers.
- Engineering estimates of energy and demand savings attributable to the program based on data collected through the on-site surveys.
- An assessment of measure life for energy efficient lighting products to address concerns that have been raised within the energy efficient lighting community about the quality and reliability of ENERGY STAR-qualifying lighting products.
- A comparison of results to a selection of past lighting studies commissioned by the Sponsors.

[1] Service territory for Efficiency Vermont covers all of Vermont except for the City of Burlington. All references to Vermont in this report reflect the service territory of Efficiency Vermont and do not include the City of Burlington.

This evaluation was primarily designed to support the development of comparative information for adjusting the common assumptions used to estimate levels of program energy savings and secondarily to provide gross and net savings impacts for the 2003 program year.

It should be noted that long-term monitoring is planned for approximately 100 of the short-term monitoring points. This long-term monitoring may affect the impact results of this study in two primary ways. First, the extended data will be used to review the accuracy of the annual operating hour expansion of the short term data with respect to seasonality. Second, the extended data will be used to re-estimate winter coincident peak lighting usage with actual winter lighting usage data. Any subsequent changes based upon the long-term data will be documented in an addendum to this report in the Spring of 2005.

Key findings from the evaluation are summarized below.

1.1. Total Catalog and Coupon Sales

Approximately 222,631 different lighting products were sold through the retail lighting and catalog program channels of the 2003 RLP; about 75% of products sold through these program channels were CFLs. (Note that 86% of the energy-efficient lighting sold through the Massachusetts RLP went through the Invitation to Participate channel, which is not addressed in this study.) As Table 1-2 shows, the vast majority of the non-ITP purchases were made through the instant rebate coupons.

Table 1-1: 2003 Catalog and Retail Lighting Products Sold

Sponsor	Number of Products			
	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres
Retail Lighting				
National Grid	39,367	13,390	1,984	3,102
NSTAR	20,884	8,419	557	1,688
Unitil	564	102	8	73
WMECo	2,523	1,702	266	968
Cape Light	2,018	1,538	157	239
Vermont	66,218	8,414	1,226	2,035
Catalog Lighting				
National Grid	13,496	1,695	843	747
NSTAR	11,302	1,417	399	946
Unitil	36	3	0	6
WMECo	7,564	1,052	527	336
Cape Light	2,640	187	71	333
Vermont	1,176	288	44	81
Total				
National Grid	52,863	15,085	2,827	3,849
NSTAR	32,186	9,836	956	2,634
Unitil	600	105	8	79
WMECo	10,087	2,754	793	1,304
Cape Light	4,658	1,725	228	572
Vermont	67,394	8,702	1,270	2,116
Grand Total	167,788	38,207	6,082	10,554

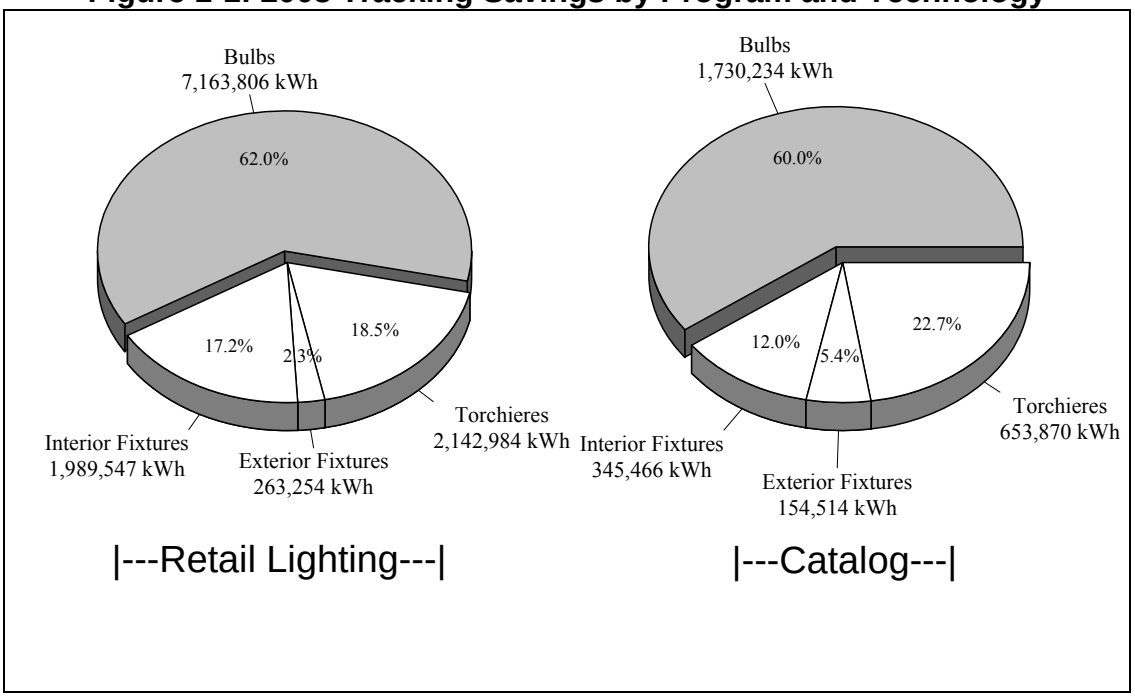
Table 1-2: Percentage of Products Purchased Through Coupon or Catalog

	Total Purchased	Coupon	Catalog
CFLs	167,788	78%	22%
Torchieres	10,554	78%	22%
Interior	38,207	88%	12%
Exterior	6,082	69%	31%

1.2. Gross Energy Savings

Figure 1-1 presents the savings from the catalog and coupon sales channels of the 2003 RLP. CFL bulb purchases account for over half of the program savings, with interior fixture and torchiere technologies accounting for nearly all the remaining program savings.

Figure 1-1: 2003 Tracking Savings by Program and Technology



Gross annual energy savings and realization rates from both coupon and catalog sales through the 2003 RLP, based on the on-site surveys performed in this study, are presented in Table 1-3. The overall realization rate is 52.8%; the precision associated with this estimate is ±13.7%. It should be noted that the fixture realization rate is based upon sponsor inputs that do not distinguish between interior and exterior fixtures. The decrease in realized savings in Massachusetts and Vermont[2] is due primarily to a low CFL installation rate and a substantial decrease in the assumed wattage reduction for torchieres.

Table 1-3: 2003 Annual Energy Savings at the Time of the Onsite

Sponsor	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	All Lighting Types
KWh Energy Savings					
National Grid	1,562,853	430,772	311,912	329,439	2,634,975
NSTAR	951,554	280,880	105,478	225,446	1,563,358
Unitil	17,739	2,998	883	6,762	28,381
WMECo	298,214	78,644	87,494	111,610	575,963
Cape Light	137,710	49,260	25,156	48,958	261,084
Vermont	1,992,450	248,497	140,123	181,110	2,562,181
Total	4,960,520	1,091,052	671,046	903,324	7,625,942
Realization Rate					
National Grid	52.1%	48.1%	172.7%	29.3%	50.7%
NSTAR	81.0%	67.4%	235.5%	30.2%	65.6%
Unitil	43.4%	30.6%	117.9%	26.0%	36.7%
WMECo	75.3%	31.6%	122.3%	58.3%	63.5%
Cape Light	79.2%	68.3%	131.5%	30.0%	61.0%
Vermont	48.5%	35.9%	138.9%	33.2%	47.0%
Total	55.8%	46.7%	160.6%	32.3%	52.8%

[2] Some Rhode Island is also included as part of the National Grid USA program activity and the Vermont activity does not include the City of Burlington.

Table 1-4 presents the energy savings and realization rates including savings from lighting products that are not yet installed but that participants report will occur in the near future—i.e., in the next year. This estimate also assumes that lighting removed since installation will not be reinstalled. Since we do not know that all lighting products that customers report they will install will actually get installed, this estimate likely overstates the actual savings that will occur. However, assuming all reported future installations are made; the overall realization rate including planned installations is 67.5%. The increase in this realization rate as compared to that calculated above is primarily driven by a 22.2% increase in CFL bulb installations that customers plan to install in the near future. This indicates that some consumers may be stocking up on the CFLs purchased through the catalog and coupon channels to have on hand when other bulbs burn out.

Table 1-4: 2003 Planned Annual Energy Savings

Sponsor	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	All Lighting Types
KWh Energy Savings					
National Grid	2,126,089	533,820	338,100	336,759	3,334,768
NSTAR	1,294,484	348,071	114,334	230,456	1,987,345
Unitil	24,131	3,716	957	6,912	35,716
WMECo	405,688	97,457	94,840	114,090	712,075
Cape Light	187,339	61,043	27,268	50,046	325,697
Vermont	2,710,509	307,942	151,888	185,135	3,355,473
Total	6,748,240	1,352,049	727,387	923,398	9,751,073
Realization Rate					
National Grid	70.9%	59.6%	187.2%	30.0%	64.1%
NSTAR	110.2%	83.5%	255.3%	30.8%	83.4%
Unitil	59.1%	37.9%	127.8%	26.5%	46.1%
WMECo	102.5%	39.2%	132.5%	59.6%	78.5%
Cape Light	107.7%	84.7%	142.5%	30.7%	76.1%
Vermont	66.0%	44.5%	150.5%	33.9%	61.6%
Total	75.9%	57.9%	174.1%	33.0%	67.5%

In qualitatively considering the on-site input parameter results by the retail versus catalog channel, there appears to be little evidence of systematic differences between the two. Differences appear to generally be indiscriminate with respect to differences among the input parameters and the technologies.

1.3. Net Energy Savings

Net energy savings are estimated from gross energy savings after adjusting for free riders and spillover from the program.[3] Free ridership is defined as the proportion of program purchases that would have been made by participants on their own, in the absence of any incentive from the Sponsors. Spillover is defined as the proportion of energy-saving lighting products that participants purchased outside the program as a result of having participated in the 2003 RLP. It should be noted that these estimates are based on survey results from program participants; non-participant spillover is not included in these estimates. As shown in Table 1-5, free ridership ranges from 6% for CFLs and torchieres to 12% for exterior fixtures, and spillover ranges from 3% for torchieres to 25% for CFLs.

Table 1-5: Net Adjustments to Gross Energy Savings

	CFLs	Torchieres	Interior Fixtures	Exterior Fixtures
Free ridership rate	6%	6%	8%	12%
Spillover rate	25%	3%	4%	7%

[3] Net adjustments are calculated here for the 2003 RLP as a whole; estimates for individual Sponsors were not intended to be within the scope of this study.

The formula for computing net energy savings is as follows:

Net energy savings = Gross energy savings x (1 + spillover rate – free ridership rate)

Table 1-6 shows net savings with free ridership and spillover taken into account. For all except CFLs, the net savings adjustments are negative—that is, they reduce the gross savings estimates. However, free ridership and spillover are associated with a transforming market, so while their effects on immediate savings may be negative (if free ridership is greater than spillover), their longer-term effects may well be positive. Moreover, because CFLs account for the largest proportion of savings, and spillover for CFLs is greater than free ridership, total net savings are greater than gross savings.

Table 1-6: Net KWh Energy Savings
Adjusted for Behavioral Influences

Sponsor	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	Total All Lighting Products
Net KWh Energy Savings					
National Grid	1,859,795	413,541	296,316	319,556	2,889,208
NSTAR	1,132,349	269,645	100,204	218,683	1,720,881
Unitil	21,109	2,878	839	6,559	31,385
WMECo	354,875	75,498	83,119	108,262	621,754
Cape Light	163,875	47,290	23,898	47,489	282,552
Vermont	2,371,016	238,557	133,117	175,677	2,918,366
Total	5,903,019	1,047,410	637,494	876,224	8,464,147
Net KWh Energy Savings Including Planned Installations					
National Grid	2,530,046	512,467	321,195	326,656	3,690,364
NSTAR	1,540,436	334,148	108,617	223,542	2,206,744
Unitil	28,716	3,567	909	6,705	39,897
WMECo	482,769	93,559	90,098	110,667	777,093
Cape Light	222,933	58,601	25,905	48,545	355,984
Vermont	3,225,506	295,624	144,294	179,581	3,845,005
Total	8,030,406	1,297,967	691,018	895,696	10,915,086

1.4. Product Status

Table 1-7 presents the status of products purchased through the 2003 RLP according to findings from the on-site survey and the telephone survey. The data show that the majority of products purchased have been installed and relatively few products have been removed. Installation rates for CFLs show the greatest disparity between the two sources, with the on-site finding 62% and the telephone survey finding 82% of CFLs installed. Status rates from the two sources for exterior fixtures provide the closest estimates. Most respondents who had not yet installed the products they purchased through the 2003 RLP put the products away for use at a later time—indicating that future savings are likely to be achieved through these products.

Table 1-7: Number Installed, Removed, or Not Yet Installed

		On-Site			Telephone Survey		
		Installed	**Removed**	**Not Yet Installed**	**Installed**	**Removed**	**Not Yet Installed**
CFLs	**n**	**302**			**407**		
	% of Program	62%	3%	32%	82%	3%	15%
Torchieres	**n**	**58**			**194**		
	% of Program	81%	3%	9%	86%	5%	9%
Interior	**n**	**115**			**328**		
	% of Program	77%	3%	21%	85%	3%	12%
Exterior	**n**	**104**			**172**		
	% of Program	80%	4%	16%	79%	4%	17%

[a] Telephone survey weighted to the population of each product.

1.5. Use of Products

The telephone survey asked program participants to describe how they use or intend to use the products purchased through the 2003 RLP.

- The majority of respondents purchased products to replace existing bulbs or fixtures, ranging from 70% for exterior fixtures to 99% for CFLs.
- Among CFL buyers, 88% replaced incandescent bulbs and 11% replaced other CFLs.
- Products purchased but not yet installed represent future savings for the Sponsors. However, participants in the on-site survey claim that of the CFLs they are storing for later use, 77% are expected to replace CFLs and 23% are expected to replace incandescents.
- We asked buyers of CFLs how they decide to use them—namely, do they just put them wherever a light is needed, or do they consider the attributes of energy efficient lighting and install them in high-use or areas where a long-life product would be beneficial? Over half (56%) of the respondents purchasing CFLs consider the most basic lighting need in deciding where to install the bulbs—that is, they put the CFLs where another bulb had burned out or where they needed a

light. However, a majority of buyers also consider at least one of the attributes of CFLs in their install decision: 27% install CFLs where lights are left on for long time periods, 12% put CFLs where they want a long-life bulb, 7% put them in hard-to-reach fixtures, and 8% put CFLs anywhere except in fixtures with dimmers or 3-way switches. Six percent of respondents place CFLs wherever they do not currently have one installed.

- All interior products were installed most frequently in the living room, a high-use area of the home. Interior fixtures and CFLs were frequently placed in the kitchen, hall, and bathroom—also high-use rooms and places where people may desire long-life products. Many CFLs, torchieres, and interior fixtures were also installed in bedrooms. Likewise, many CFLs were also placed on the exterior of the house or in the basement. Customers, then, appear to be placing products in places where lighting products are used most frequently or where a long-lived product would be useful.
- The total number of CFLs currently in use as reported by all respondents in the telephone survey averages nine per home and just over 14 per home in the on-site survey. The self-report for the sub-sample of telephone respondents who participated in the on-site study was just over 10 CFLs. This indicates that telephone survey respondents underestimate their usage of CFLs.[4]
- The on-site survey looked at the potential for CFLs to replace incandescent bulbs throughout the home. Only 8.0% of the incandescent bulbs found during the on-site visits cannot be replaced by a compact fluorescent. The most common types of incandescents without a compact fluorescent counterpart were clear bulbs and frosted bulbs; other types included decorative, colored, and heat lamps.

[4] Or that there is a bias in that those who agree to an on-site visit tend to be those who are more "energy conscious" and/or the on-site participants may have installed a few more bulbs between the time they were recruited and the time of the on-site, in anticipation of the site visit (so that they could "look better" for the auditor).

Table 1-8 illustrates the on-site observed wattage reduction rates by technology and compares them to the assumptions used by the Sponsors. The Sponsors assume significantly higher wattage reductions for every lighting product than those found in the on-sites, except exterior fixtures. The wattage reduction noted in the interior fixture product category appears low compared to sponsor assumptions, as the sponsor assumptions did not differentiate interior from exterior. In addition, many interior fixtures were noted to be one-for-one replacement, similar to CFL bulbs.

Table 1-8: Average Wattage Reduction Results

Impact Parameter	Compact Fluorescent Bulb (n=170)	Interior Fixtures (n=89)	Exterior Fixtures (n=83)	Torchieres (n=47)
On-Site				
Result *90% Confidence Interval*	**48.7** **±5.0%**	**48.7** **±10.0%**	**94.7** *±11.4%*	**115.8** *±15.5%*
Result for Catalog only	**48.2**	**47.0**	**80.5**	**118.3**
Result for Retail only	**49.6**	**50.6**	**110.8**	**110.4**
Sponsor Assumptions				
National Grid, Unitil, & NSTAR	**54.8**	**73.5***	**73.5***	**261.0**
WMECO	50.0	**84.1**	84.1	**158.3**
Vermont	**54.6**	**67.4**	**67.4**	**218.7**

* Average of Retail and Catalog Installation Rate Assumptions.
Bold face indicates a statistically significant difference between sponsor assumptions and on-site averages.

Table 1-9 illustrates the logger-informed average daily hours of use by technology and compares these results to the sponsor assumptions. The average daily hours of use ranges from a low of 2.1 for interior fixtures to a high of 4.0 for exterior fixtures (the latter primarily driven by exterior lighting on photocell). Although the daily hours of use for the individual fixture comparisons are statistically different between the on-sites and sponsors, the simple average daily hours for the combined fixtures is 3.1, which is similar to the National Grid, Unitil, and WMECo assumption.

Table 1-9: Average Daily Hours of Use Results

Impact Parameter	Compact Fluorescent Bulb (n=97)	Interior Fixtures (n=71)	Exterior Fixtures (n=78)	Torchieres (n=44)	Overall
On-Site					
Result *90% Confidence Interval*	**2.7** **±17.7%**	**2.1** **±24.3%**	**4.0** *±17.7%*	**2.5** **±23.9%**	2.9 **±10.4%**
Result for Catalog only	**2.6**	**2.1**	**3.8**	**2.7**	2.9
Result for Retail only	**2.7**	**2.1**	**4.2**	**1.8**	2.8
Sponsor Assumptions					
National Grid & Unitil	**3.4**	**3.4**	**3.4**	**3.5**	
WMECO	**2.4**	**3.1**	**3.1**	**2.6**	
NSTAR	**2.4**	**2.4**	**2.4**	**3.5**	
Vermont	**3.4**	**3.4**	**3.4**	**3.4**	

Bold face indicates a statistically significant difference between sponsor assumptions and on-site averages.

1.6. Comparison to Other Studies

The following tables compare the input parameters calculated from the current study to similar studies performed in the region in the last several years. The current study made a distinction between interior and exterior fixtures; however, most other studies do not provide results at this level. Potential reasons for differences among the study results are discussed in detail in Section 1 of this report.

Table 1-10: Installation Rate Value Comparison

Study	In Store Lamps	Catalog Lamps	In Store Fixtures	Catalog Fixtures	In Store Torchieres	Catalog Torchieres
Current Study Install Rates *90% Confidence Interval*	61.6% *±7.5%*	61.6% *±7.5%*	Int: 76.5% *±10.1%* / Ext: 79.8% *±9.9%*	Int: 76.5% *±10.1%* / Ext: 79.8% *±9.9%*	81.0% *±13.1%*	81.0% *±13.1%*
1998 Starlights Study	73.1%	81.4%	60.6%	90.0%		
2000 Torchiere Study					86.3%	86.3%
2000-01 NU SLC/RL Study	70%	65%	80%	77%	74.3%	87.6%
2002 NSTAR RHU HOO Study	82%					
2002-2003 NH RLP Study	62.3%	62.3%	53.2%	53.2%	87.5%	87.5%

Table 1-11: Wattage Reduction Rate Value Comparison

Study	In Store Lamps	Catalog Lamps	In Store Fixtures	Catalog Fixtures	In Store Torchieres	Catalog Torchieres
Current Study Wattage Reduction Rates *90% Confidence Interval*	48.7 *±5.0%*	48.7 *±5.0%*	Int: 48.7 *±10.0* / Ext: 94.7 *±11.4*	Int: 48.7 *±10.0* / Ext: 94.7 *±11.4*	115.8 *±15.5%*	115.8 *±15.5%*
1998 Starlights Study	54.8	54.8	75.4	71.5		
2000 Torchiere Study					261.0	261.0
2000-01 NU SLC/RL Study	52.0	47.0	104.0	65.0	193.0	118.0
2002-2003 NH RLP Study	40.9	40.9	85.3	85.3	169.9	169.9

Table 1-12: Daily Hours of Use Rate Value Comparison

Study	In-Store Lamps	Catalog Lamps	In-Store Fixtures	Catalog Fixtures	In-Store Torchieres	Catalog Torchieres
Current Study Daily Hours *90% Confidence Interval*	2.7 *±17.7%*	2.7 *±17.7%*	Int: 2.1 *±24.3%* / Ext: 4.0 *±17.7%*	Int: 2.1 *±24.3%* / Ext: 4.0 *±17.7%*	2.5 *±10.4%*	2.5 *±10.4%*
1998 Starlights Study	3.4	3.44	3.4	3.44		
2000 Torchiere Study					3.46	3.46
2000-01 NU SLC/RL Study	3.4	4.5	3.0	3.0	3.4	3.4
2002 NSTAR RHU Program	2.39					
2002-2003 NH RLP Study	4.7	4.7	3.2	3.2	3.7	3.7

1.7. Participant Awareness

The telephone survey assessed participant experience with energy-efficient lighting products.

- The majority of program participants claim to have known about energy-efficient lighting products prior to the 2003 RLP. Seven out of ten (71%) respondents say they had at least a little knowledge of CFLs prior to the 2003 RLP, with 25% claiming above average or excellent knowledge. Slightly fewer (65%) had at least a little knowledge of CFL fixtures, with 16% claiming above average or excellent knowledge.
- Catalog customers are significantly more likely than coupon customers to have had at least an above average knowledge of CFLs prior to the program; conversely, coupon customers are significantly more likely than catalog customers to have had no knowledge of CFLs.
- Those familiar with CFLs have been aware of them for an average of six years; those familiar with CFL fixtures have been aware of them for an average of five years.
- While the majority of participants were familiar with energy-efficient lighting products prior to their participation in the 2003 RLP, only 45% had bought or received any CFLs and only 27% had bought or received any CFL fixtures prior to the program. There is a longer history of utility-sponsored programs in MA and RI compared to VT, and respondent experience with CFLs reflects this (46% in MA and RI and 38% in VT had bought or received CFLs prior to the program). The majority of participants either purchased or received the CFLs or CFL fixtures through a utility or energy efficiency program; this finding underscores the importance of utility support in bringing these products to homes.

1.8. Measure Life

Due to limitations in the data currently available through PEARL and other sources, we can not recommend any definitive adjustments to assessing measure life at this time.

We offer an indication of the extent to which products sold through the 2003 RLP may be a concern due to their loss of ENERGY STAR status. However, we note that the reasons for products failing to maintain their ENERGY STAR status may be varied. Products can be disqualified for failing to meet any of the ENERGY STAR testing, performance, labeling, or packaging standards and manufacturers can voluntarily pull products from the ENERGY STAR qualifying list for any number of reasons (i.e., retiring or discontinuing a product line, etc.) that may not even be associated with product performance. In other words, we can not make an assumption about product measure life based on failure to meet ENERGY STAR standards.

This analysis provides only an indication of the potential ceiling for the number of products that potentially have measure life problems.

- At least 27,754 CFLs, representing 18 different product models and 17% of the CFLs sold through the 2003 RLP, have been disqualified from the ENERGY STAR listing. As Table 1-13 shows, the majority of the disqualified CFLs were sold through the Vermont program—34% of the CFLs sold in Vermont. Two of the disqualified CFL models sold in Vermont represent sales of 20,681 bulbs.
- In addition, at least 1,694 CFLs sold through the 2003 RLP, representing 15 product models, were discontinued or retired from the ENERGY STAR listing.

Table 1-13: Number of CFLs Sold Through the 2003 RLP Taken Off ENERGY STAR List

	Disqualified	Discontinued/Retired
Total 2003 RLP	27,754	1,694
MA-RI RLP	4,588	1,435
Catalog	2,632	457
Coupon	1,956	978
VT RLP	23,166	259
Percent of CFLs sold through 2003 RLP	17%	1%

It is also important to note that the ENERGY STAR program review of products is on-going and products can be disqualified or discontinued at any time of the year. This means that ENERGY STAR-qualifying products selected for inclusion in Sponsor programs in good faith may lose their ENERGY STAR status at a later point in time; this occurred with some products sold through the 2003 RLP. The loss of ENERGY STAR status is an on-going problem for Sponsors and retailers.

1.9. ITP Purchases

- ITP purchases comprised the bulk of 2003 RLP sales in MA and RI (VT had no ITP program in 2003), but are not part of this evaluation. Because customer data are not collected by the Sponsors for those who made discounted product purchases at participating retailers through the ITP process, identifying these customers would have required significant effort in a separate sampling task.
- However, the gross impact parameters estimated in this study can be applied to ITP purchases; net impact adjustments (free ridership and spillover) to gross estimates do not apply to ITP purchases.

1.10. Comparison of Telephone Survey Results to On-Site Survey

We compare selected parameters from the telephone survey to corresponding measures collected in the on-sites. The results help to identify differences in self-reported and actual behavior and the directionality of the differences. We also examine ways to leverage the relationship between the on-site and telephone survey data to take advantage of the larger sample size of the latter and the greater accuracy of the former. In addition to comparing on-site results with the telephone survey results of those who received on-site visits, we also compare both sets of results to the overall telephone survey results. Triangulation among the three samples forms the basis of our recommended "correction factors" for other telephone surveys to be conducted in the future. We note that the correction factors offered in this analysis are subject to verification in other studies and are unique to MA, RI, and VT at this time; they will likely change as the energy efficient lighting market continues to evolve in the region.

- We recommend that the Sponsors consider using "adjustment" or "correction factors" to guide assumptions that will be used for 2005 planning purposes; this recommendation is based on a couple of factors: As evidenced by a greater number of products installed, lower operating hours, and demographic differences, there appears to be some self-selection of customers who may have a greater proclivity toward energy efficiency in the on-site sample compared to the non-logged telephone sample. In addition, the logged results are observed results for a small number of people, but do not offer acceptable precision levels due to the limited sample size. Once the logged numbers are extrapolated to the larger survey population, we arrive at a number that incorporates actual observations with better precision.
- The recommended correction factors are derived by taking the ratio of the logged results to self-reported results among the group participating in logging, and multiplying that ratio times the responses from the overall telephone sample. This approach takes into account differences between the logged and non-logged groups, and is therefore superior to the logging results by themselves.

- The proper "correction factor" of total CFL counts to use for other telephone surveys is the ratio of on-site counts (14.4 per household) to the self reports among the on-site sample (9.2 per household). The suggested ratio would result in a "correction factor" of 1.6.
- Respondent self-reports of installed RLP purchases tend to be higher than logged counts for CFLs, lower for torchieres, and about the same for interior and exterior fixtures. The overestimates of installed RLP CFLs may result from respondents' inability to recall which CFLs they purchased through catalog and retail coupon channels and those they purchased through other channels, and an inability to distinguish between those purchased in 2003 and those purchased before or since. Correction factors are 0.68 of telephone results for CFLs, 1.40 for torchieres, 1.00 (no correction factor) for interior fixtures, and 1.13 for exterior fixtures.
- Compared to self-reports, verified installation rates are lower for nearly all product types and channels and self-reported installation rates. Self-reports for CFLs and exterior fixtures are closer to verified installation rates among coupon purchasers than among catalog purchasers. Correction factors for telephone survey results are 0.74 for CFLs, 0.88 for torchieres, 0.84 for interior fixtures, and 0.90 for exterior fixtures.
- The average daily self-reported use of CFLs is higher than logged use. This suggests that telephone respondents over-report the number of hours they use CFLs.[5] Respondents also tend to over-report hours of use for interior fixtures, but not for torchieres or exterior fixtures. Correction factors for telephone survey results are 0.81 for CFLs, 1.04 for torchieres, 0.84 for interior fixtures, and 0.93 for exterior fixtures.
- To investigate possible reasons for differences between telephone survey results and the on-site logger study and to guide assumptions for adjustments that will be used for 2005 planning purposes, we looked at demographic and product location as possible drivers for the differences in values. We found that there are some differences in the demographic characteristics of respondents who participated in the logger study and those who did not, but the two groups continue to share many of the general characteristics that differentiate them from the general population.
- Also, there is a significant difference in the distribution of products in several areas of the home when comparing the non-logged survey installations to the logged products; the difference in the living room is the biggest concern, due to the high installation rates of products in the room and the fact that it is a high lighting-use area of the home. For each product type—CFLs, torchieres, and interior fixtures—the living room represents a greater proportion of the household product distribution by the non-logged survey respondents compared to logged respondents.

[5] It is also possible that the early spring timing of the telephone survey affected summer use estimates. People may not have accurately accounted for how they would use lights in May and June, when the logging typically occurred. Perhaps the long-term lighting study will provide clarification, as it will include time periods with shorter days.

1.11. Demographics

People buying efficient lighting products through the 2003 RLP are significantly different than the general population on most demographic characteristics. Respondents are more likely than the general population to be have a graduate degree, to live in single-family homes, to own rather than rent, to be in the 35 to 54 age group, and to have lower middle or high incomes rather than low or higher-middle incomes. In addition, respondents tend to be men rather than women, indicating that more men are making purchases of energy efficient lighting products, or at least having their names put on coupons and catalog orders (in conducting the survey, we asked to speak to a specific individual—the name on the coupon or order form).

Respondents who participated in the on-site logger study differ from those who did not participate in the logger study on a few demographic characteristics, including being younger, having higher incomes, owning their home, and being single or having children. However, the two groups continue to share many of the general characteristics that differentiate them from the general population. In addition, we also noted a tendency for respondents not logged to have higher refusal rates on many demographic questions compared to those who participated in the logger study. Higher refusal rates for demographic questions among those not logged is consistent with a slightly older population and a lack of willingness to participate in the logger study.

2. Description of the Program and Evaluation Components

2.1. Program Description

The Residential Lighting Program (RLP) is intended in part for resource acquisition—in which measurable energy savings are the key objectives—and in part for market transformation by increasing the use and availability of energy-efficient lighting products in Massachusetts, Rhode Island, and Vermont. The Sponsors independently administer their own RLP's, while generally sharing a common market-based approach to encourage customers to purchase energy-efficient lighting products. All Sponsors support and follow ENERGY STAR guidelines. The 2003 RLPs offered instant rebate coupons redeemable at local retailers and sold products at discounted prices through catalogs. A third component of the RLP in MA and RI programs (VT had no ITP program in 2003) was the Invitation to Participate (ITP) discount at participating retailers. The retail component offered customers an immediate discount on selected ENERGY STAR-qualifying lighting products at the cash register with participating retailers. Customers were required to provide personal information including name, address, telephone number, and utility name on the rebate coupon form. Rebate amounts varied by product type and sponsor, ranging from $2 to $4 per CFL bulb, $15 to $25 per interior lamp or fixture, $10 to $15 per exterior fixture, and $20 to $25 per torchiere. The catalog component included the limited distribution of hard-copy catalogs, the ENERGY STAR Lights Catalog, the Smart Living Catalog and an on-line catalog. Catalog sales offered a selection of lighting products at a discount of about 50% off of the regular retail prices.

In 2003, some of the Sponsors also administered another market-based approach to encourage the use of energy efficient lighting in the form of Invitation to Participate (ITP) sales. ITP sales are buy-down promotions of selected ENERGY STAR-qualifying lighting products at local retailers, negotiated with manufacturers and/or retailers. This evaluation focuses only on sales of lighting products sold through the instant rebate and catalog components.

The Energy Federation, Inc. (EFI) served as the fulfillment contractor for both instant rebates and catalog sales for the Sponsors. EFI processes the instant rebate coupons received from participating retailers. EFI pays the retailers and invoices the appropriate utility based on the customer's address. For the catalog, EFI receives customer orders through the phone, mail, or web and ships the products from its inventory. EFI then invoices the appropriate utility for part of the cost of the rebated products ordered.

2.2. Evaluation Objectives

The primary goal of this study is to provide the Sponsors with updated feedback about program impacts; specifically, the Sponsors are interested in seeing how operating hours and wattage saved have changed since the 1998 *Process and Impact Evaluation of Joint Utilities Starlights Residential Lighting Program* and the 2000 torchiere-only study. The impact factors that the evaluation measures are: in-service rates, free-ridership, participant spillover, hours of use, lifetime hours, annual and lifetime maximum demand reduction, summer coincident peak reduction, winter coincident peak reduction, and energy savings by winter peak, winter off-peak, summer peak, and summer off-peak categories for various ENERGY STAR-qualifying lighting products, including CFLs, interior fixtures, exterior fixtures, and torchieres.

3. Methodology

This study integrates data and findings from a variety of evaluation activities, including:

- Telephone survey among 823 customers who participated in the 2003 RLP through instant coupon purchases from local retailers or catalog purchases.
- On-site surveys at 128 sites using lighting loggers at the homes of participating customers.
- Engineering estimates of energy and demand savings attributable to the program based on data collected through the on-site surveys.
- An assessment of measure life for energy-efficient lighting products to address concerns that have been raised within the energy efficient lighting community about the quality and reliability of ENERGY STAR-qualifying lighting products.
- A comparison of results to a selection of past lighting studies commissioned by the Sponsors.

3.1. Participant Survey

A telephone survey was conducted among 823 customers who participated in the 2003 RLP through instant coupon purchases from local retailers or catalog purchases. While the original sample called for 810 people, in order to ensure adequate representation of all product types from Vermont, we actually surveyed 823 people. The telephone survey is used to estimate free ridership, spillover, and in-service rates for products sold through the program; although only the on-site in-service rate results were used in the calculations of energy savings in this report. These measurements are based on the self-reported intentions of participants rather than an accounting of their actions.

All telephone surveys were conducted by our subcontractor, Research America, Inc. (RAI) using computer-assisted telephone interviewing (CATI). The survey was conducted from April 26 through May 6, 2004.

The sample of 2003 RLP instant coupon and catalog participants was derived from customer transaction databases provided by EFI and the Vermont Energy Investment Corporation (VEIC)[6]. As fulfillment contractor to the program, EFI maintains databases of all qualifying instant rebate redemptions and catalog/mail-order sales. EFI provided all program transaction files for MA and RI; VEIC provided an abbreviated version of the EFI records for VT. Considerable effort was necessary to clean the data for use, including merging numerous data sources, identifying unique participants (through common customer id numbers, telephone numbers, names, and/or addresses), aggregating individual transaction listings by customer, and determining how records fulfilled the desired sampling options. While the customer and product counts from the complete databases of 2003 coupon and catalog customers in MA, RI, and VT are used for

[6] VEIC is the organization that currently holds the contract to administer Efficiency Vermont, the state-wide energy efficiency utility.

program impact measurements in this study, only records with complete telephone contact numbers were used for the final telephone sample.

The EFI lists contained 138,565 records of individual and multiple purchases of products made through residential lighting programs (RLP) using either a catalog or in-store, instant-rebate coupon in the states of Massachusetts, Rhode Island, and Vermont. These files indicate that the program sponsors paid rebates on 167,788 CFLs, 38,207 interior fixtures (including portables but not torchieres), 10,554 torchieres, and 6,082 exterior fixtures. After excluding unusable records, we aggregated the product records to identify the purchases of individual customers (based on their account or phone number).[7] A total of 59,128 customers had purchased at least one product, usually more, through the RLP. (Table 3-1)

Respondents in the telephone survey were asked to describe in detail the status of all of products they purchased through the 2003 RLP. To reduce overburdening respondents who had purchased all four types of products—CFLs, torchieres, interior fixtures, and outdoor fixtures—they were asked questions pertaining to only three types of products, randomly selected during the survey process.

Table 3-1: Population of Customers Purchasing Each Combination of Products

(all customers participating in the RLP)

	MA	RI	VT	Overall
Bulbs only	16,854	4,647	12,945	34,446
Interior Only	9,040	1,763	1,837	12,640
Exterior Only	1,170	381	349	1,900
Torchiere Only	3,596	397	751	4,744
Bulbs & Interior	1,329	166	780	2,275
Bulbs & Exterior	422	62	112	596
Bulbs & Torchiere	696	61	384	1,141
Interior & Exterior	164	23	72	259
Interior & Torchiere	295	26	96	417
Exterior & Torchiere	28	3	8	39
Bulbs, Interior, Exterior	119	15	53	187
Bulbs, Interior, Torchiere	230	14	114	358
Bulbs, Exterior, Torchiere	39	8	10	57
Interior, Exterior, Torchiere	11	1	2	14
All Products[a]	35	2	18	55
Total	34,028	7,569	17,531	59,128

[a] In order to limit the length of the survey, we only asked customers a randomly selected three of the four products.

[7] The records were unusable because they did not include a unique identifier such as phone or account number. The total number of unusable records was 7,059 or 5% of all records sent to us by EFI. All these records are associated with purchases made using the in-store coupon. The actual number of people excluded from the population counts was most likely far fewer than 7,000 since many of the records represented multiple purchases by the same individuals.

In creating the sampling criteria, the Sponsors agreed to combine Massachusetts and Rhode Island, as patterns of use are likely to be similar; Vermont, coming into the project later in the design process, was allocated 10% of the survey sample. The sample provides for breakdowns by four technology types: CFL bulbs (including replacement bulbs), interior fixtures (including portable table and floor lamps), exterior fixtures, and torchieres. Catalog and coupon sales were combined.

While the telephone survey preceded the on-site visits temporally, the onsite visits took precedence conceptually because the telephone survey was used to recruit participants for the on-site portion of the project. Because the sample was driven by the sample size targeted for the on-site visits, sample sizes are not proportionate to the population. Table 3-2 lists the telephone survey sample sizes by state and product type, along with the sampling error. The sampling design was able to achieve fairly low sampling errors, 10% or lower, for all states and products except Vermont.[8] The error for Vermont was substantially higher at 22%; this reflects the fact that customers from Vermont were not added to the survey population until a later date, due to the later addition of the state to the overall study. This resulted in under-sampling of buyers according to the actual mix of product types purchased in Vermont.

Table 3-2: Sample Size and Sampling Error Overall and by State, Product, and Product

	Population Size (N)[a]	Sample Size (n)	Sampling Error
Total Sample	59,128	823	7.0%
By State			
Massachusetts	34,028	631	4.1%
Rhode Island	7,569	98	9.4%
Vermont	17,531	94	21.7%
By Product[b]			
Bulbs	39,115	415	10.2%
Interior Fixtures	16,205	343	5.5%
Exterior Fixtures	3,107	180	6.6%
Torchieres	6,825	199	6.3%
By Program			
In-Store/Coupon	50,655	514	8.5%
Catalog	8,473	309	6.2%

[a] Excludes individuals with neither an identifiable account nor phone number. Without one or the other piece of information, we could not identify unique individuals in the data set, a necessity given that many customers made multiple purchases and at different times of the year.

[b] Totals exceed population and sample sizes due to purchases of multiple types of products by individual customers. Such customers are counted in total for both types of products.

Table 3-3 details purchases of multiple product types by respondents; Table 3-4 provides the same information, with breakdowns by catalog and coupon sales channels. While this evaluation was designed to combine catalog and coupon sales, in some cases we provide

[8] A ten percent sampling error at a 90% confidence level indicates that nine out of ten surveys with samples derived the same way would produce results within 10% of the level found in the current survey.

additional breakdowns by sales channel; these results should be viewed with caution because of the small sample sizes.

Table 3-3: Number of Survey Respondents by State and Product Type[a]

	MA	RI	VT	Overall
Bulbs only	135	39	9	183
Interior Only	157	22	9	188
Exterior Only	52	15	15	82
Torchiere Only	82	8	12	102
Bulbs & Interior	60	7	17	84
Bulbs & Exterior	43	2	7	52
Bulbs & Torchiere	35	3	12	50
Interior & Exterior	13	1	2	16
Interior & Torchiere	12	1	3	16
Exterior & Torchiere	4	0	0	4
Bulbs, Interior, Exterior	17	0	2	19
Bulbs, Interior, Torchiere	14	0	6	20
Bulbs, Exterior, Torchiere	7	0	0	7
Total	631	98	94	823

[a] No individuals surveyed had purchased all three types of fixtures but not bulbs. In addition, in order to limit the length of the survey, no individual was asked about their purchases of all four products (NB: only 55 individuals in the entire population had purchased all four types of products).

Table 3-4: Number of Survey Respondents by State, Product Type, and Sales Channel[a]

	Massachusetts		Rhode Island		Vermont		Overall		Total
	Instant Coupon	Catalog	Instant Coupon	Catalog	Instant Coupon	Catalog	Instant Coupon	Catalog	
Bulbs only	89	46	32	7	8	1	129	54	**183**
Interior Only	127	30	22	0	9	0	158	30	**188**
Exterior Only	32	20	15	0	14	1	61	21	**82**
Torchiere Only	55	27	6	2	12	0	73	29	**102**
Bulbs & Interior	14	46	4	3	15	2	33	51	**84**
Bulbs & Exterior	6	37	2	0	7	0	15	37	**52**
Bulbs & Torchiere	3	32	2	1	12	0	17	33	**50**
Interior & Exterior	4	9	0	1	2	0	6	10	**16**
Interior & Torchiere	4	8	1	0	3	0	8	8	**16**
Exterior & Torchiere	2	2	0	0	0	0	2	2	**4**
Bulbs, Interior, Exterior	2	15	0	0	2	0	4	15	**19**
Bulbs, Interior, Torchiere	0	14	0	0	6	0	6	14	**20**
Bulbs, Exterior, Torchiere	2	5	0	0	0	0	2	5	**7**
TOTAL	**340**	**291**	**84**	**14**	**90**	**4**	**514**	**309**	**823**

[a] No individuals surveyed had purchased all three types of fixtures but not bulbs. In addition, in order to limit the length of the survey, no individual was asked about their purchases of all four products (NB: only 55 individuals in the entire population had purchased all four types of products).

ITP purchases comprised the bulk of 2003 RLP sales, but are not part of this evaluation. Because customer data are not collected by the Sponsors for those who made discounted product purchases at participating retailers through the ITP process, identifying these customers would have required significant effort in a separate sampling task. So as not to count ITP purchases as spillover among participants in the instant rebate and catalog portions of the program, the Sponsors advised us to identify ITP purchases based on the price paid (CFL purchases $3.00 or less and fixture purchases $10 or less were identified

as ITP purchases)[9]. Confirmation of the purchases through consumer identification, product type/models, and retailer purchased from were considered as alternative means for ITP identification. However, noting that consumers may not know whether or not additional product purchases were even done through the ITP program, difficulties in the identification of product types, and the number of participating retailers, these options were rejected.

Weighting procedures

We weighted the telephone survey data for two reasons. First, as previously discussed, we did not use a directly proportionate sample. Instead, our stratified design over sampled those who had purchased all types of fixtures or live in Rhode Island; it under sampled those who purchased bulbs or live in Massachusetts and Vermont. Second, one of the main objectives of the participant survey was to provide data on the impact of the entire program. In order to do this, we needed to generalize from the sample to the populations of both program participants and the number of products actually purchased.

The objectives of the participant survey required that we use two distinct weighting systems. The first system is based on customers, and it weights the sample to the population of individuals purchasing energy-efficient products through the RLP in all three states. We use this weighting system whenever we want to draw conclusions about *customers* and not *products* (e.g., about customer satisfaction or certain types of buying and usage behavior). The second weighting procedure is based on the actual number of products purchased through the RLP. We weight the number of products that survey respondents report purchasing to the actual number of products purchased by all customers through the RLP. We use this second weighting procedure whenever we wish to draw conclusions about the products purchased through the RLP. This second weighting procedure is modified for some questions to offer further details on catalog and in-store coupon sales. In this adjusted method, we use the proportions of catalog and coupon sales purchased through the RLP to allocate product estimates between the two modes of program delivery.

Because the survey respondents represent a random sample of the population, both weighting procedures allow us to draw conclusions about the overall population based on the responses and reported behavior of the survey respondents. However, all generalizations to the population are subject to the assumptions and limitations of statistical procedures. In particular, no random sample will ever provide an exactly accurate description of the true population. All generalizations made from a sample to the population are only estimates. Triangulation, or using diverse methods to answer a similar question, helps us evaluate any single method. For this reason, the larger study provides estimates developed from the participant survey and those obtained from the on-site logger studies and assessment of the population database. We believe that the use of different methods of analysis enables us to assess the reliability of the data.

[9] While Vermont had no ITP program in 2003, some Vermont retailers participating in the instant coupon initiative offered CFLs at a retail price of $3.09, before the $3 rebate.

3.2. On-Site Visits

Respondents to the telephone survey were recruited to participate in the on-site portion of this study so that measure installation could be validated and lighting loggers could be used to validate and refine gross and net energy savings. At the conclusion of each telephone interview, respondents were offered an incentive of $75 for allowing for an on-site visit in their home. Given the tight time frame under which this evaluation was being conducted, toward the end of the recruiting period when the sample of customers who had purchased exterior fixtures was exhausted, we increased the incentive to $100 to encourage participants who had purchased exterior fixtures to reconsider participating in the on-site portion of the survey.

On-Site Sample Design and Selection

The performance of the on-site visits and metering of the lighting operating hours required the selection of sample points from the participant sample frame—i.e., the population of program activity as provided by EFI. The approach employed in this study targets precision levels by four categories of lighting technology. This sampling approach provides an opportunity to account for differences that are believed to vary by technology, such as differences in usage behaviors, installation rates, and other factors. Therefore, the on-site sample points were designed to achieve precision levels for each savings input parameter for the four primary lighting technology groups: CFLs, interior fixtures, exterior fixtures, and torchieres. The sample sizes required to develop the lighting savings estimates from the on-site visits and metering are calculated based on the following formula:

$$n_0 = \left(\frac{z \times E}{R} \right)^2 \qquad n_1 = \left(\frac{n_0}{1 + \frac{n_0}{N}} \right)$$

where,

n0	=	the required sample size before adjusting for the size of the population,
z	=	a constant based on the desired level of confidence—e.g., 1.645 for the 90% level of confidence,
E	=	Error ratio describing the relationship between the observed savings and the predictor for observed savings,
R	=	the desired relative precision,
n1	=	the required sample size after adjusting for the size of the population using the finite population correction factor,
N	=	the population size, i.e., the number of sample points.

The error ratio is of central importance to this sample design. Since the calculated inputs of this study will not be known until study completion, historical error ratios were used to estimate the sample sizes needed. Table 3-5 shows the error ratios of the lighting savings input parameters as determined from a previous study by RLW and NMR for residential

lighting[10]. The indoor and outdoor fixtures are the same as they were not distinguished from one another in the analysis of the previous study.

Table 3-5: Error Ratios of Similar Study

Input Parameter	Precision	Qty Units	Error Ratio
CFL			
Operating Hours	12.2%	197	1.04
Wattage Reduction	6.6%	197	0.56
In-service Rate	8.8%	316	0.95
Indoor Fixture			
Operating Hours	22.5%	50	0.97
Wattage Reduction	16.2%	50	0.70
In-service Rate	12.4%	94	0.73
Outdoor Fixture			
Operating Hours	22.5%	50	0.97
Wattage Reduction	16.2%	50	0.70
In-service Rate	12.4%	94	0.73
Torchiere			
Operating Hours	26.8%	21	0.75
Wattage Reduction	17.8%	21	0.50
In-service Rate	10.5%	24	0.31

Having gathered reasonable error ratio estimates, together with the population of program activity, we calculated the sample sizes required to achieve a 90/10 savings estimate at the program level. However, allowing the various products to fall into the sample randomly generated higher precision levels at the lighting technology level for those technologies purchased more frequently than others. Therefore, we allocated the overall 90/10 sample among the lighting technologies of interest to provide an 18.5% precision level for each input parameter at a 90% level of confidence. Table 3-6 includes the total number of each product sold through the program, the number of each lighting technology type targeted in the sample based on the poorest error ratio for that technology among the input parameters, the number of customers visited who bought each product and the final number of products in the on-site sample. A total of 128 individual homes were visited in the data collection.

[10] *The 2002-03 Process and Impact Evaluation of the New Hampshire Residential Lighting Program*. Public Service Company of New Hampshire, Unitil Energy Systems, Inc., New Hampshire Electric Cooperative, Connecticut Valley Electric Company, Granite State Electric Company. Nexus Market Research, Inc. and RLW Analytics, Inc., November 9, 2003.

Table 3-6: Final Sample Sizes by Lighting Technology

Lighting Technology	Qty in Population	Estimated Number of Technologies to Achieve 90/18.5	Customers Visited with each Lighting Technology	Final Number of each Technology purchased at on-sites
CFL	163,130	90	59	258
Interior Fixture	36,482	78	46	101
Exterior Fixture	5,854	78	45	103
Torchiere	9,982	44	34	56
Total	215,448	290	184	518

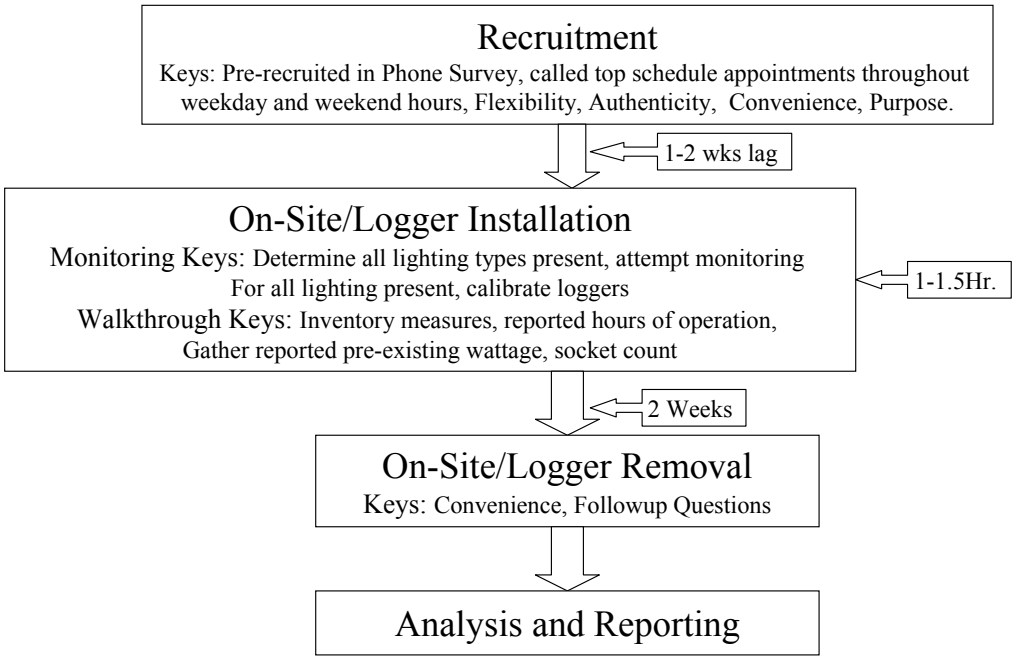
On-Site Visit Data Collection

The on-site data collection activities included a brief interview with the participant to orient the auditor to the home and lighting locations, the on-site audit, and metering using lighting logger monitoring. PS&T lighting loggers were installed to accurately measure lighting hours of use for a minimum period of two weeks. The lighting logger data set was used to support the evaluation through the development of annual hours of use for lighting measures, as well as the accuracy of the common assumptions being used by the sponsors. A total of 233 loggers were installed across the 128 homes visited in support of the study, including 35 loggers in Vermont.

These loggers were installed to represent all purchased products in each home visited. This was done regardless of which lighting technology the home was selected for, with the exception of bulbs in non-bulb sample points. That is, if a bulb sample point was selected, all bulbs and all other technologies were logged at that home. If a non-bulb sample point was selected, only non-bulb purchases were logged. This approach was taken due to logger limitations, the desire for target precisions among all technology types, and the need for the logging of only 90 bulbs to achieve the targeted hours of use precision. There were only a handful of instances in which logging according to this protocol was not possible. These instances included one exterior fixture that was not logged due to its height (second floor), and 15 interior fixtures (14 at one home) in which the homeowner asked not to install loggers as they would be visible and obtrusive. All bulb and torchieres under the logger protocol were logged. Through this logger protocol, the installed loggers captured the hours of operation of 290 lighting purchases (several loggers were able to log multiple purchased lighting products on the same control switch).

Figure 3-1 presents an overview of the data collection activities, including the steps of recruitment, on-site audit, logger removal, and analysis. Included in the figure are the lag times associated with each step and the keys to successfully completing each phase of the data collection.

Figure 3-1: On-Site Data Collection Flow Chart



4. Impact Results

This section summarizes results of catalog and retail coupon sales in the 2003 Residential Lighting Program (RLP) in Massachusetts, Rhode Island, and Vermont based on data collected in the telephone and on-site surveys and subsequent engineering estimates. This evaluation was primarily designed to support the development of comparative information for adjusting the common assumptions used to estimate levels of program energy savings and secondarily to provide gross savings impacts for the 2003 program year. This section provides an overview of program activity, a discussion of the sampling approach used for the on-sites, the on-site and analysis methodologies, and all appropriate savings results and savings input comparisons. Free ridership and spillover estimates, based on telephone survey results, are also provided.

It should be noted that long-term monitoring is planned for approximately 100 of the short-term monitoring points. This long-term monitoring may impact the impact results of this study in two primary ways. First, the extended data will be used to review the accuracy of the annual operating hour expansion of the short term data with respect to seasonality. Second, the extended data will be used to re-estimate winter coincident peak lighting usage with actual winter lighting usage data. Any subsequent changes based upon the long term data will be documented in an addendum to this report in the spring of 2005.

The key methods used to calculate the net and gross savings due to lighting product sales in the Catalog and Retail lighting program were as follows:

- 823 telephone surveys with participants in the 2003 RLP
- 128 site visits to verify measure installation and operation (stratified by lighting technology type),
- Telephone interviews to assess net-to-gross factors,
- Lighting logger metering for two week periods to directly measure hours of use, and
- Engineering estimation to develop savings data for each lighting product sale.

4.1. Program Tracking Summary

Datasets for both the Retail Lighting and Lighting Catalog purchases in 2003 were provided by EFI[11] and VEIC[12] to the NMR team at the outset of the study. These datasets included information about the lighting technology purchased, program channel, rebates provided, and sometimes a description of the lighting product. However, it should be noted that ITP lighting purchases are not analyzed in this evaluation. ITP purchases are estimated to produce a majority of program savings; however, at project initiation it was decided that including these purchases in the current work scope would have been too expensive and time consuming given the study limitations. It is believed that the gross impact parameters estimated in this study are reasonable to apply to ITP purchases; items such as free ridership and spillover do not apply to ITP purchases.

The tracking data gathered for the Retail Lighting and Lighting Catalog did not contain the energy savings estimate for each lighting type purchased; however, through use of the common assumptions on energy savings, we are able to estimate the assumed lighting savings by program and lighting technology. The common assumptions being used by the sponsors and their sources are shown in Table 4-1 below. It should be noted that there might be slight differences in how the various lighting products are categorized among the sponsors and this study (e.g., the sponsors combine interior and exterior fixtures, while the study evaluated each separately). However, in general, these assumptions provide a first approximation of each sponsor's per-unit energy savings. For purposes of this study, replacement CFLs were considered CFL bulbs and interior fixtures included portable CFLs.

[11] Massachusetts and Rhode Island activity.
[12] Vermont activity.

Table 4-1: Sponsor Input Parameter Assumptions for ENERGY STAR Lighting

Sponsor Specific Savings Input Parameters	Retail Lamps	Catalog Lamps	Retail Fixtures	Catalog Fixtures	Retail Torchieres	Catalog Torchieres
Wattage						
Average Wattage Reduction NGRID, Unitil, NSTAR[1]	54.8	54.8	75.4	71.5	261[4]	261[4]
Average Wattage Reduction WMECO[3]	50	50	84.1	84.1	158.3	158.3
Average Wattage Reduction Vermont	54.6	54.6	67.4	67.4	218.7	218.7
Hours of Use						
Average Hours of Use/Day[1] used by National Grid and Unitil	3.4	3.44	3.4	3.44	3.46[4]	3.46[4]
Average Hours of Use/Day[2] used by NSTAR	2.4	2.4	2.4	2.4	3.46[4]	3.46[4]
Average Hours of Use/Day[3] used by WMECo	3.2	3.2	3.75	3.75	3.23	3.23
Average Hours of Use/Day used by Vermont	3.4	3.4	3.4	3.4	3.4	3.4
Installation Rates						
Installation Rate used by National Grid	81.6%	87.7%	60.6%	90.0%	88.9%	87.1%
Installation Rate used by WMECo[3]	67.2%	67.2%	78.4%	78.4%	78.7%	78.7%
Installation Rate used by NSTAR	73.1%[1]	81.4%[1]	60.6%[1]	90.0%[1]	85.5%[4]	87.1%[4]
Installation Rate used by Unitil	100%	100%	100%	100%	100%	100%
Installation Rate used by Vermont	90%	90%	95%	95%	95%	95%

1. 1998 Process and Impact Evaluation of Joint Utilities Starlights Residential Lighting Program
2. 2002 NSTAR Residential High Use Program Operating Hours Realization Study
3. 2002 Western Massachusetts Lighting Impact Study
4. 2000 joint utility Compact Fluorescent Torchiere Impact Evaluation,

These assumptions result in the per-unit savings estimates shown in Table 4-2 for each sponsor. The savings per unit have been calculated in the following formula:

Wattage Reduction * Hours of Use/Day * 365 * Installation Rate/1000

Table 4-2: kWh Energy Savings by Lighting Product and Sponsor

Sponsor	In Store Lamps	Catalog Lamps	In Store Fixtures	Catalog Fixtures	In Store Torchieres	Catalog Torchieres
National Grid	55.5	60.3	56.7	80.8	293.0	287.1
Unitil	68.0	68.8	93.6	89.8	329.6	329.6
NSTAR	35.1	39.1	40.0	56.4	281.8	287.1
WMECo	39.2	39.2	90.2	90.2	146.9	146.9
Vermont	61.0	61.0	79.5	79.5	257.8	257.8

The tracking system data set for 2003 activity provided by EFI and VEIC was the foundation for the sample design, selection, and analysis. Table 4-3 presents the number of products purchased by lighting technology type in the Retail Lighting or Catalog Program by sponsor according to the data. These data do not include ITP purchases. These data span across three states: Rhode Island, Massachusetts and Vermont. The data collected from the tracking systems were for all of 2003. Approximately 222,631 different lighting products have been purchased through either the retail lighting or catalog program channels. Approximately 75% of products purchased through the program were compact fluorescent bulbs.

Table 4-3: 2003 Catalog and Retail Lighting Products Sold by Sponsor and Program

Sponsor	Number of Products			
	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres
Retail Lighting				
National Grid	39,367	13,390	1,984	3,102
NSTAR	20,884	8,419	557	1,688
Unitil	564	102	8	73
WMECo	2,523	1,702	266	968
Cape Light	2,018	1,538	157	239
Vermont	66,218	8,414	1,226	2,035
Catalog Lighting				
National Grid	13,496	1,695	843	747
NSTAR	11,302	1,417	399	946
Unitil	36	3	0	6
WMECo	7,564	1,052	527	336
Cape Light	2,640	187	71	333
Vermont	1,176	288	44	81
Total				
National Grid	52,863	15,085	2,827	3,849
NSTAR	32,186	9,836	956	2,634
Unitil	600	105	8	79
WMECo	10,087	2,754	793	1,304
Cape Light	4,658	1,725	228	572
Vermont	67,394	8,702	1,270	2,116
Grand Total	167,788	38,207	6,082	10,554

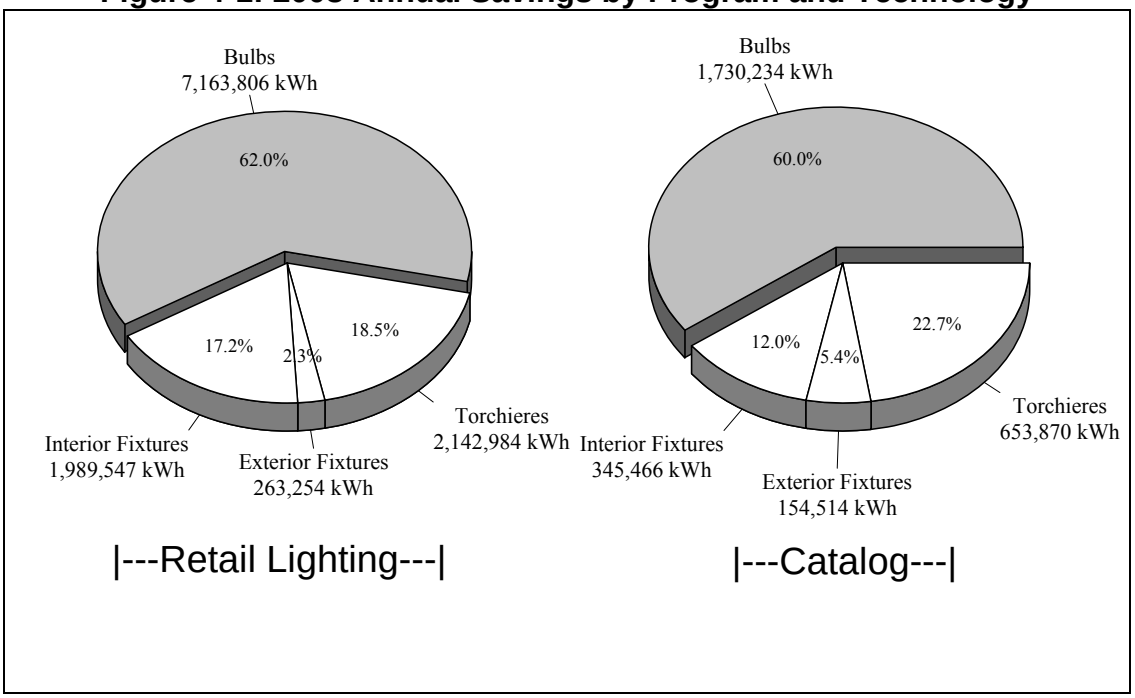
Table 4-4 presents the estimate of program tracking savings for Retail Lighting and Lighting Catalog activity in 2003 among the program sponsors. The NSTAR per-unit savings have been used to estimate the savings for Cape Light Compact in this table. Calculated in this manner, the majority of savings in the program is associated with the retail lighting program (81%), with 62% of overall savings due to the purchase of efficient bulbs. It should be noted that the calculation for interior and exterior fixtures used the same fixture assumptions according to program channel, as interior vs. exterior assumptions were common.

Table 4-4: Catalog and Retail Lighting Annual Energy Savings by Sponsor in 2003

Sponsor	Total Tracked kWh Savings				
	Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	All Lighting Types
Retail Lighting					
National Grid	2,184,615	759,270	112,501	908,977	3,965,363
NSTAR	732,851	336,983	22,295	475,716	1,567,846
Unitil	38,356	9,544	749	24,062	72,711
WMECo	99,015	153,602	24,006	142,176	418,798
Cape Light	70,815	61,561	6,284	67,356	206,015
Vermont	4,038,155	668,587	97,419	524,697	5,328,858
Total	7,092,991	1,927,986	256,970	2,075,629	11,353,576
Catalog Lighting					
National Grid	814,398	136,952	68,113	214,461	1,233,924
NSTAR	441,636	79,877	22,492	271,593	815,598
Unitil	2,477	269	0	1,978	4,724
WMECo	296,848	94,941	47,561	49,350	488,699
Cape Light	103,160	10,541	12,852	95,603	222,157
Vermont	71,716	22,885	3,496	20,885	118,982
Total	1,627,074	334,924	141,661	558,267	2,661,926
Total					
National Grid	2,999,012	896,223	180,614	1,123,438	5,199,287
NSTAR	1,174,487	416,861	44,787	747,309	2,383,444
Unitil	40,833	9,814	749	26,040	77,435
WMECo	395,862	248,542	71,566	191,526	907,497
Cape Light	173,975	72,102	19,137	162,959	428,172
Vermont	4,109,871	691,472	100,916	545,582	5,447,840
Grand Total	8,720,065	2,262,911	398,631	2,633,896	14,015,503

Figure 4-1 presents the tracking savings for the Lighting program by Retail versus Catalog purchases by technology. In the Retail Lighting program, bulb purchases account for just over half of the program savings, with interior fixture and torchiere technologies accounting for nearly all the remaining program savings. Like the Retail Lighting channel, in the Catalog channel, the majority of savings is due to the purchase of bulbs, with torchieres contributing just over 25% of the total savings.

Figure 4-1: 2003 Annual Savings by Program and Technology



4.2. Lighting Analysis Methodology

This section presents the methodology used to calculate the various input parameters based on the data collected in the on-site visits, including the summer and winter coincident factor calculations. The analysis was performed in a spreadsheet with inputs for all of the on-site information gathered for each lighting product purchased in the homes visited.

While participants were generally able to provide pre-purchase wattages for most locations (including instances where metering could not be performed), there were some instances in which the lighting purchased through the program did not replace a previously existing light. In these instances, phone survey results on the wattage replaced for each lighting technology type by room location was used to estimate the pre-existing wattage. This approach to handling these instances assumes that the homeowner would have purchased a lighting product for the same location if they had not done so through the program.

One drawback to using lighting loggers in this evaluation was that the data were collected primarily during months with long periods of sunlight (May and June). Therefore, many

lights required seasonal adjustments for the development of the annual hours of operation and winter coincident operation. To determine the annual hours of operation, RLW used information from a long-term metering study performed for NEES in 1994[13]. This study and approach was selected for two primary reasons. First, the expansion of annual hours of use from the NEES study was found to provide similar results when compared to the expansion of annual hours based upon a similar study performed in Tacoma, WA in a recent NSTAR evaluation. Second, based upon the fact that using both reports provided similar expansion results, it was decided that the NEES study was more appropriate for use as it covered the same geographic region as the current study.

The NEES long-term monitoring study calculated the percentage of total annual hours that fell into each month of the year. These data were then used to annualize the short-term monitored data in the RLW Study by adjusting the monthly hours observed in the short-term metering by the fraction of annual hours determined to fall during those same months in the long-term study. When the metering occurred entirely in one month (i.e., May or June), that month's fraction was used; otherwise the average of the May and June fraction was used. The hours of use by month from the long-term metering study performed for NEES are shown in Table 4-5.

Table 4-5: Monthly Hours of Use

Month	Total Hours	Percentage of Total Annual Hours
January	136.5	11.36%
February	137.1	11.41%
March	106.8	8.89%
April	96.8	8.05%
May	97.4	8.10%
June	84.8	7.05%
July	70.8	5.89%
August	61.8	5.14%
September	68.1	5.67%
October	83.2	6.92%
November	130.8	10.88%
December	127.9	10.64%
Total	1,202.0	100.00%

[13] *Residential Lighting Study*, New England Electric Systems, Xenergy, 1994.

To calculate overall program savings, the engineering estimation of annual lighting energy savings per lighting product was derived from the equation:

Annual kWh savings = (Delta Watts x Hours)/1000

This algorithm is a straightforward and simple calculation, with the proper inputs for the wattage reduction and hours of use taken from the on-site field inspection and the lighting logger data analysis, respectively. To estimate the program-level results, we calculated the estimated savings for each lighting product as informed by the determined hours of use, installation rates, and delta watts, and expanded each per unit savings estimate to the population based upon the number of each product purchased. The comparison of data between the on-sites and the common assumptions was performed through average hours of use, average displaced wattage and install rates identified on-site for each technology.

Lighting loggers were installed to accurately measure lighting hours of use for a minimum period of two weeks on as many program lighting products as possible at each home visited. There were a handful of instances where loggers could not be installed, primarily in exterior fixtures that were either out of reach (e.g., high roofs) or when logging was not permitted due to customer request. However, RLW performed logging on the vast majority of lighting products installed at the homes visited, including locations that were difficult to log such as chandeliers and recessed lighting. The lighting logger data were used to develop annual hours of use and to inform the savings estimates of the lighting observed, as well as the accuracy of the common assumptions being used by the sponsors.

Summer coincident peak was calculated as the logged percent on-time between the hours of 12 noon and 4 PM from June through September. As logging occurred during May and June, no adjustments were made to those on-times calculated during this period used to estimate summer peak usage.

Winter coincident peak was calculated as the logged percent on-time between the hours of 5 PM and 7 PM for all other months. As logging occurred during summer months, adjustments were required to estimate winter peak usage. Specifically, each lighting product purchased at the sampled homes was placed into one of four categories, with winter peak times calculated differently for each one. It should be noted that this is a stopgap analysis intended to provide an estimate of peak winter coincident usage; a more direct estimate of winter coincident operation will be calculated following the extended metering. The categories and peak estimate calculations are bulleted below.

- Category 1 included photocell exterior fixtures. For these fixtures, RLW used sunset hours during the months of interest to determine the percent on-time during the winter peak period.
- Category 2 included lighting products located in interior rooms or other instances of lighting usage in which the logger data suggested the lighting usage does not change by season (e.g., in bathrooms where the lighting pattern appeared the same

regardless of sunlight). For these fixtures, RLW used sunset hours to determine the percent on-time during the winter peak period.

- Category 3 included lighting products in homes where people either work and are home by 5 PM or do not work. For these products, the percent on time for the hour and a half immediately following sunset during the logged period (beginning 8:30 PM) was used to characterize winter peak usage.
- Category 4 included lighting products in homes where people work and are home after 5pm according to questions asked on-site. For these products, the percent on time for the hour and a half immediately following sunset during the logged period (beginning 8:30 PM) was used to characterize winter peak usage during the time they are home between 5 PM and 7 PM.

4.3. Gross Savings Results

Lighting Technology Installation Rates

The persistence rates as determined from the on-site survey are expressed in Table 4-6. The table shows the average and totals for number of bulbs in the following categories, according to on-site observations and customer reporting of purchase totals[14]:

1) Installed in the customers' homes,
2) Never Installed,
3) Installed outside of the customers' homes,
4) Plans to Install,
5) Installed and Removed, and
6) Not Purchased.

[14] If a customer reported they did not install any lighting in the phone survey recruitment stage and that person was selected for inclusion in the on-site recruitment they were included in the installation rate calculation even though they were not visited.

The lighting product with the lowest installation rate at the time of the on-site was CFL bulbs, which were installed approximately 61.6% of the time. The primary reason for non-installation of CFLs among the sampled sites was that the customer was holding the lighting purchase to replace burned-out bulbs in the future. This suggests that these purchased bulbs will generate energy savings, albeit in future years. Torchieres have the highest installation rate with 81.0%.

Table 4-6: Installation and Removal Rates from On-Sites

Action Taken	Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres
Currently Installed Within Sponsor Service Territory				
Installed in Customer's Home	186	88	78	46
Installed in Other Home in MA, RI, or VT	0	0	5	1
Total Installed in MA, RI, or VT	186	88	83	47
Percent Installed	61.6%	76.5%	79.8%	81.0%
Currently Not Installed Within Sponsor Service Territory				
Not Installed	116	27	21	11
Installed Outside MA, RI, and VT	0.3%	0.0%	0.0%	3.4%
Installed and Removed	3.3%	2.6%	3.8%	3.4%
Customer Plans To Install	22.2%	2.6%	6.7%	1.7%
Never Installed, No Plan to Inst. or DK	9.3%	18.3%	9.6%	6.9%
Not Purchased	3.3%	0.0%	0.0%	3.4%
Total Sample	302	115	104	58

Lighting Technology Hours of Use, Wattage Reduction and Installation Rates

Table 4-7 below illustrates the on-site observed installation rates by technology and compares them to the assumptions used by the sponsors. This table includes all lighting technologies observed in the on-sites. The 90 percent confidence interval is shown for each estimate at the overall program level. The average installation rate ranges from a low of 61.6% for CFLs to a high of 81.0% for torchieres. The overall program installation rate at the time of the on-site was determined to be 66.5%, with a precision of ±5.1%. The installation rate including customer reported planned installations in the next year was determined to be 83.2%.

Table 4-7: Installation Rates by Technology from On-Sites

Impact Parameter	Compact Fluorescent Bulb (n=302)	Interior Fixtures (n=115)	Exterior Fixtures (n=104)	Torchieres (n=58)
On-Site				
Result at time of visit *90% Confidence Interval*	**61.6%** **±7.5%**	**76.5%** **±10.1%**	**79.8%** *±9.9%*	**81.0%** *±13.1%*
Result incl. planned installs	**83.8%**	**94.8%**	86.5%	82.8%
Result for Catalog only	**58.6%**	**81.8%**	72.3%	88.2%
Result for Retail only	**76.2%**	**72.9%**	90.7%	82.1%
Sponsor Assumptions				
WMECO	**67.2%**	**78.4%**	78.4%	78.7%
National Grid USA	**84.6%**	**75.0%***	75.0%*	88.0%
NSTAR	**77.3%**	**75.0%***	75.0%*	86.3%
Unitil	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Vermont	**90%**	**95%**	**95%**	**95%**

* Average of Retail and Catalog Installation Rate Assumptions.
Bold face indicates a statistically significant difference between sponsor assumptions and on-site average results at the time of the on-site.

Table 4-8 presents the reported duration before installation among customers with installed lighting among the on-site sample. Almost all (89.6%) installations occurred within one month of purchase, with 81.3% occurring within a week of the purchase.

Table 4-8: Duration Until Installation

Time Between Purchase and Installation	Total # of Measures	% of Total
Immediately	99	25.7%
Within One Week	214	55.6%
1-3 weeks	32	8.3%
1-3 months	33	8.6%
More Than 3 Months	7	1.8%
Total Sample	**385**	**100.0%**

Table 4-9 illustrates the on-site observed inputs for wattage displaced by technology and compares them to the assumptions used by the sponsors. This table includes all lighting technologies observed in the on-sites. The 90 percent confidence interval is shown for each estimate. The average wattage reduction ranges from a low of 48.7 for CFLs to a high of 115.8 for torchieres. The overall program average delta watts is 66.0, with a precision of ±6.0%. Exterior fixture displaced wattage is slightly higher than what might be expected; however, most exterior fixtures purchased through the program were found to replace pre-existing wattages of between 100 and 150 watts.

In the fixture calculations, this study calculated wattage reductions for interior and exterior fixtures independently, although each sponsor uses a single wattage reduction assumption across both fixture types. This explains some of the change in interior fixture wattage reduction between the sponsor estimate and the on-site estimate. In addition, many interior fixtures were noted to be one for one replacement, similar to CFL bulbs. However, the simple average wattage displacement for the combined fixtures is 71.9, which provides an estimate that is generally close to those used by the sponsors.

It is important to note that some halogen torchieres replaced through the program may have had a dimmable feature that would decrease the pre-purchase wattage when not fully lit, although this was not actively explored in this study. In the Xenergy torchiere study[15], all locations with torchieres were found to operate at full illumination between 61% and 100% of the time. Halogen torchiere replacements were found occasionally in this study, and in these instances the displaced wattage calculation was based on full halogen use, or the maximum wattage of the reported halogen. This may result in a small overestimation of wattage reduction, although this impact is believed to be negligible overall.

Table 4-9: Average Wattage Reduction Results

Impact Parameter	Compact Fluorescent Bulb (n=170)	Interior Fixtures (n=89)	Exterior Fixtures (n=83)	Torchieres (n=47)
On-Site				
Result *90% Confidence Interval*	**48.7** **±5.0%**	**48.7** **±10.0.%**	**94.7** *±11.4%*	**115.8** *±15.5%*
Result for Catalog only	**48.2**	**47.0**	**80.5**	**118.3**
Result for Retail only	**49.6**	**50.6**	**110.8**	**110.4**
Sponsor Assumptions				
National Grid, Unitil, & NSTAR	**54.8**	**73.5***	**73.5***	**261.0**
WMECO	50.0	**84.1**	84.1	**158.3**
Vermont	**54.6**	**67.4**	**67.4**	**218.7**

* Average of Retail and Catalog Installation Rate Assumptions.
Bold face indicates a statistically significant difference between sponsor assumptions and on-site averages.

[15] *2000 Xenergy Torchiere Study*. National Grid, NSTAR, Fitchburg Gas & Electric and Long Island Power Authority, with the Northeast Energy Efficiency Partnerships, Inc.

Clearly, the category with the largest discrepancy between measured and assumed wattage displaced is torchieres. In the on-sites, the displaced wattage was determined to be 115.8 watts, as compared to 158 and 261 in the sponsor assumptions. As part of the on-site, the auditor verified the post wattage of the torchieres, which was found to vary little from the wattages tracked in the EFI database. In researching the cause of the difference, the primary reason for changes in displaced watts between the common assumptions and the on-site results for torchieres appears to be that customers are using program-purchased lighting to replace lighting of a lower wattage than the program assumes. For instance, the average post wattage in the torchieres observed on-site was 62.7 watts, compared to the assumed pre-wattage of 323 watts for National Grid, Unitil, and NSTAR and 221 watts for WMECo (after adding in the assumed displacement wattages). This suggests that torchieres purchased through the program are replacing lighting of at least 200-330 watts. In fact, while approximately 26% of the torchieres observed on-site were found to replace higher-wattage halogen torchieres, the remaining torchieres were replacing incandescent portables, which have much lower pre-purchase wattages associated with them. This is generally consistent with the phone survey results, which show that only about one-third of CFL torchieres replaced fixtures with halogen bulbs.

Table 4-10 below illustrates the logger-informed average daily hours of use by technology and compares these results to the sponsor assumptions. As described earlier, the logger data from this study were gathered in May and June, but were adjusted for seasonality impacts through use of extended metering data from an earlier study performed by XENERGY[16]. This table includes all lighting technologies and loggers installed at the on-sites. The 90 percent confidence interval is shown for each estimate. The average daily hours of use ranges from a low of 2.1 for interior fixtures to a high of 4.0 for exterior fixtures (the latter primarily driven by exterior lighting on photocell). The overall program average daily hours of use are 2.9, with a precision of ±10.4%. Although the daily hours of use for the individual fixture comparisons are statistically different between the on-sites and sponsors, the simple average daily hours for the combined fixtures is 3.1, which is similar to the National Grid, Unitil, and WMECo assumption.

Table 4-10: Average Daily Hours of Use Results

Impact Parameter	Compact Fluorescent Bulb (n=97)	Interior Fixtures (n=71)	Exterior Fixtures (n=78)	Torchieres (n=44)	Overall
On-Site					
Result *90% Confidence Interval*	**2.7** **±17.7%**	**2.1** **±24.3%**	**4.0** *±17.7%*	**2.5** **±23.9%**	2.9 **±10.4%**
Result for Catalog only	**2.6**	**2.1**	**3.8**	**2.7**	2.9
Result for Retail only	**2.7**	**2.1**	**4.2**	**1.8**	2.8
Sponsor Assumptions					
National Grid & Unitil	**3.4**	**3.4**	**3.4**	**3.5**	
WMECO	**2.4**	**3.1**	**3.1**	**2.6**	
NSTAR	**2.4**	**2.4**	**2.4**	**3.5**	
Vermont	**3.4**	**3.4**	**3.4**	**3.4**	
Bold face indicates a statistically significant difference between sponsor assumptions and on-site averages.					

In qualitatively considering the on-site input parameter results by the retail versus catalog channel, there appears to be little evidence of systematic differences between the two. Differences appear to generally be indiscriminate with respect to the differences among the input parameters and the technologies.

4.4. Summer and Winter

Based on the analysis described in the methodology section, the weighted winter coincident factor from the on-sites is estimated to be 25.3% ±9.9% and the weighted summer coincident factor is estimated to be 12.1% ±19.6%. It should be noted that extended metering is currently in the field, which will provide actual logger data from winter months. This data will be used to calculate a more accurate winter peak estimate in the early spring of 2005.

[16] *Residential Lighting Study*, New England Electric Systems, Xenergy, 1994.

4.5. Gross Savings Impacts

These assumptions provided in the on-site result tables generate per-unit savings estimates according to Table 4-11.

Table 4-11: kWh Annual Energy Savings per Lighting Product

Scenario	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres
At time of on-site	29.6	28.6	110.3	85.6
Including Planned installations	40.2	35.4	119.6	87.5

Table 4-12 presents the annual savings as calculated from the input parameters gathered at the time of the on-site and the products purchased according to the EFI and VEIC databases. Further, this table presents the realization rate as calculated against Table 4-4. The overall realization rate from information collected at the time of the on-sites is 52.8%, although it should be noted that the fixture realization rate is based upon sponsor inputs that do not distinguish between interior and exterior fixtures. The precision associated with this estimate is ±13.7%. The decrease in realized savings in Massachusetts and Rhode Island is due primarily to a low CFL installation rate and a substantial decrease in the assumed wattage reduction for torchieres. One item to note in this table is that these savings estimates are for annual savings; however, reduced run times that impact these savings estimates do not detract from lifetime savings and are likely to result in purchased lighting lasting longer.

Table 4-12: 2003 Annual Energy Savings at the Time of the Onsite

Sponsor	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	All Lighting Types
Number of Products Purchased					
National Grid	52,863	15,085	2,827	3,849	74,624
NSTAR	32,186	9,836	956	2,634	45,612
Unitil	600	105	8	79	792
WMECo	10,087	2,754	793	1,304	14,938
Cape Light	4,658	1,725	228	572	7,183
Vermont	67,394	8,702	1,270	2,116	79,482
Total	167,788	38,207	6,082	10,554	222,631
KWh Energy Savings					
National Grid	1,562,853	430,772	311,912	329,439	2,634,975
NSTAR	951,554	280,880	105,478	225,446	1,563,358
Unitil	17,739	2,998	883	6,762	28,381
WMECo	298,214	78,644	87,494	111,610	575,963
Cape Light	137,710	49,260	25,156	48,958	261,084
Vermont	1,992,450	248,497	140,123	181,110	2,562,181
Total	4,960,520	1,091,052	671,046	903,324	7,625,942
Realization Rate					
National Grid	52.1%	48.1%	172.7%	29.3%	50.7%
NSTAR	81.0%	67.4%	235.5%	30.2%	65.6%
Unitil	43.4%	30.6%	117.9%	26.0%	36.7%
WMECo	75.3%	31.6%	122.3%	58.3%	63.5%
Cape Light	79.2%	68.3%	131.5%	30.0%	61.0%
Vermont	48.5%	35.9%	138.9%	33.2%	47.0%
Total	55.8%	46.7%	160.6%	32.3%	52.8%

Table 4-13 presents the savings as calculated from an installation rate that assumes savings from customer-reported planned installations. That is, the installation rates used to determine savings in this table include the installation of lighting products that purchasers report will occur in the near future, i.e., in the next year. This table also presents the realization rates as calculated against Table 4-4. Since we do not know that all lighting products that customers report they will install will actually get installed, this estimate likely overstates the actual savings that will occur. This estimate also assumes that lighting removed since installation will not be reinstalled. However, assuming all reported future installations are made; the overall realization rate from information collected at the time of the on-site as well as planned installations is 67.5%. The increase in this realization rate as compared to that calculated above is primarily driven by a 22.2% increase in CFL bulb installations that are planned by customers at this time but were not installed at the time of the on-site.

Table 4-13: 2003 Planned Annual Energy Savings

Sponsor	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	All Lighting Types
Number of Products Purchased					
National Grid	52,863	15,085	2,827	3,849	74,624
NSTAR	32,186	9,836	956	2,634	45,612
Unitil	600	105	8	79	792
WMECo	10,087	2,754	793	1,304	14,938
Cape Light	4,658	1,725	228	572	7,183
Vermont	67,394	8,702	1,270	2,116	79,482
Total	167,788	38,207	6,082	10,554	222,631
KWh Energy Savings					
National Grid	2,126,089	533,820	338,100	336,759	3,334,768
NSTAR	1,294,484	348,071	114,334	230,456	1,987,345
Unitil	24,131	3,716	957	6,912	35,716
WMECo	405,688	97,457	94,840	114,090	712,075
Cape Light	187,339	61,043	27,268	50,046	325,697
Vermont	2,710,509	307,942	151,888	185,135	3,355,473
Total	6,748,240	1,352,049	727,387	923,398	9,751,073
Realization Rate					
National Grid	70.9%	59.6%	187.2%	30.0%	64.1%
NSTAR	110.2%	83.5%	255.3%	30.8%	83.4%
Unitil	59.1%	37.9%	127.8%	26.5%	46.1%
WMECo	102.5%	39.2%	132.5%	59.6%	78.5%
Cape Light	107.7%	84.7%	142.5%	30.7%	76.1%
Vermont	66.0%	44.5%	150.5%	33.9%	61.6%
Total	75.9%	57.9%	174.1%	33.0%	67.5%

4.6. Net Energy Savings

Net energy savings are estimated from gross energy savings after adjusting for free ridership and spillover from the program[17]. It should be noted that these estimates are based on survey results from program participants; non-participant spillover is not included in these estimates.

Free Ridership

Free ridership estimates are derived from the telephone survey. Free ridership is defined as program purchases that would have been made by participants on their own within three months, in the absence of any incentive from the sponsors. The estimate is based on the following:

- Awareness of efficient lighting product prior to program
- Intention to buy product about the same time as they participated in the program
- Willingness to pay average retail price for the same number of products purchased.

Table 4-14 shows that free ridership ranges from 6% for CFLs and torchieres to 12% for exterior fixtures.

Table 4-14: Free Rider Estimate

(all respondents with prior knowledge of product, who purchased products, and who would have bought at the same time or within three months of purchase)[a]

	CFLs	Torchieres	Interior Fixtures	Exterior Fixtures
n	93	24	53	29
Full Free Rider Purchases[b]	9,618	626	3,072	709
Partial Free Rider[c]	7,860	249	895	0
Total Free Rider Purchases	17,478	875	3,967	709
Total Number of Products Purchased	167,788	10,554	38,207	6,082
% Free Rider Purchases	6%	6%	8%	12%
% Including Partial Free Rider Purchases	10%	8%	10%	12%

[a] Weighted to the population of each product purchased.

[b] "Don't know" responses removed from total.

[c] Partial free ridership occurs when participants planned to purchase a smaller number of products than were purchased through the program; only those products that would have been purchased without the program are counted as partial free rider purchases.

[17] Net adjustments are calculated here for the 2003 RLP as a whole; estimates for individual Sponsors were not intended to be within the scope of this study.

Table 4-15 presents free ridership estimates for coupon and catalog purchase channels. Coupon customers are significantly more likely than catalog customers to be free riders on purchases of torchieres and exterior fixtures, while catalog customers are significantly more likely than coupon customers to be free riders on CFL purchases. However, it should be noted that the sample sizes are quite small and the findings should be interpreted accordingly.

Table 4-15: Free Rider Estimates by Purchase Channel

(all respondents with prior knowledge of product, who purchased products, and who would have bought at the same time or within three months of purchase)[a]

	CFLs		Torchieres		Interior Fixtures		Exterior Fixtures	
	Coupon	**Catalog**	**Coupon**	**Catalog**	**Coupon**	**Catalog**	**Coupon**	**Catalog**
n	50	43	12	12	34	19	19	10
Full Free Rider	6,507	3,233	559	126	2,804	359	617	181
Partial Free Rider	7,463	1,249	307	32	707	108	0	0
Total Free Riders	13,970	4,482	866	158	3,511	467	617	181
% Free Rider Purchases[c]	5%[d]	9%	7%[d]	5%	8%	8%	15%[d]	10%
% Including Partial Free Rider Purchases	11%[d]	12%	11%[d]	7%	10%	10%	15%[d]	10%

[a] Weighted to the population of each product purchased.
[b] "Don't know" and unusable responses removed from free rider estimates.
[c] Based on the total product population by method of purchase.
[d] Significantly different from catalog at the 90% confidence level.

Spillover

This leads us to the estimate of spillover purchases. Spillover is defined as the proportion of energy-saving lighting products that participants purchased outside the program as a result of having participated in the 2003 RLP. It should be noted that these estimates are based on survey results from program participants; non-participant spillover is not included in these estimates. To determine spillover rates, we look only at those customers who say that the 2003 RLP influenced their decision to purchase additional CFLs or fixtures. We then subtract the number of likely ITP purchases (based on the assumption that purchases of CFLs for $3 or less and fixture purchases of $10 or less were ITP purchases) from all post-RLP purchases for each of these respondents, removing any outliers and "don't know" responses in the process. The result for each customer gives us their individual spillover rate. Then, we sum the spillover purchases for all customers claiming the program influenced them and divide this result by the total number of purchases made through the program. The final result is the spillover rate.

Table 4-16 shows that spillover ranges from 3% for torchieres to 25% for CFLs.

Table 4-16: Assessment of Spillover

(all respondents reporting the RLP influenced their purchase of additional products)[a]

	CFLs	Torchieres	Interior Fixtures	Exterior Fixtures
n[b]	137	27	24	25
A. Spillover Purchases	42,566	280	1,422	404
B. Program Purchases	167,788	10,554	38,207	6,082
C. Spillover Rate **(Line A ÷Line B)**	25%	3%	4%	7%

[a] Weighted to the population of program participants.

[b] "Don't Know" responses and outliers from the number of additional products purchased removed.

Table 4-17 shows the spillover rates for coupon and catalog customers. With the exception of torchieres, there are significant differences between coupon and catalog customers. Coupon customers buying interior fixtures and exterior fixtures are more likely to buy outside of the program; catalog customers however, are more likely than coupon customers to buy CFLs outside of the program.

Table 4-17: Assessment of Spillover by Purchase Channel

(all respondents reporting the RLP influenced their purchase of additional products)[a]

	CFLs		Torchieres		Interior Fixtures		Exterior Fixtures	
	Coupon	Catalog	Coupon	Catalog	Coupon	Catalog	Coupon	Catalog
n	77	60	17	10	18	6	16	9
Spillover Purchases	29,328	13,701	205	79	1992	36	275	99
% Spillover[c]	22%[d]	38%	3%	3%	6%[d]	1%	7%[d]	5%

[a] Weighted to the population of each product. "Don't Know" responses and outliers from the number of additional products purchased removed.

[c] Based on the total product population by method of purchase.

[d] Significantly different from catalog at the 90% confidence level.

Net Energy Savings

Net energy savings is a function of gross energy savings modified by causality and customer use characteristics. Here we define it as a function of the gross energy savings impacted by free ridership and spillover:

Net energy savings = Gross energy savings x (1 + spillover rate – free ridership rate)

For all except CFLs, the net savings adjustments are negative—that is, they reduce the gross savings estimates. However, free ridership and spillover are associated with a transforming market, so while their effects on immediate savings may be negative, their longer-term effects may well be positive. Moreover, because CFLs account for the largest proportion of savings, and spillover for CFLs is greater than free ridership, total net savings are greater than gross savings.

Table 4-18: Net KWh Energy Savings
Adjusted for Behavioral Influences

Sponsor	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	Total All Lighting Products
Net KWh Energy Savings					
National Grid	1,859,795	413,541	296,316	319,556	2,889,208
NSTAR	1,132,349	269,645	100,204	218,683	1,720,881
Unitil	21,109	2,878	839	6,559	31,385
WMECo	354,875	75,498	83,119	108,262	621,754
Cape Light	163,875	47,290	23,898	47,489	282,552
Vermont	2,371,016	238,557	133,117	175,677	2,918,366
Total	5,903,019	1,047,410	637,494	876,224	8,464,147
Net KWh Energy Savings Including Planned Installations					
National Grid	2,530,046	512,467	321,195	326,656	3,690,364
NSTAR	1,540,436	334,148	108,617	223,542	2,206,744
Unitil	28,716	3,567	909	6,705	39,897
WMECo	482,769	93,559	90,098	110,667	777,093
Cape Light	222,933	58,601	25,905	48,545	355,984
Vermont	3,225,506	295,624	144,294	179,581	3,845,005
Total	8,030,406	1,297,967	691,018	895,696	10,915,086

4.7. Study Error Ratios for Future Use

As stated earlier, the error ratio is of central importance to any sample design. Below, in Table 4-19, we provide the error ratios for this study. These error ratios can be used to estimate the sample sizes of future studies of the lighting program.

Table 4-19: Error Ratios from Current Study

Input Parameter	Precision	Qty Units	Error Ratio
CFL			
Operating Hours	17.7%	98	1.06
Wattage Reduction	5.0	186	0.42
In-service Rate	7.3%	292	0.75
Indoor Fixture			
Operating Hours	24.3%	71	1.24
Wattage Reduction	10.0%	88	0.57
In-service Rate	10.1%	104	0.63
Outdoor Fixture			
Operating Hours	17.7%	78	0.94
Wattage Reduction	11.4%	83	0.63
In-service Rate	9.9%	114	0.64
Torchiere			
Operating Hours	23.9%	44	0.96
Wattage Reduction	15.5%	47	0.64
In-service Rate	13.1%	56	0.591

4.8. Massachusetts and Rhode Island ITP Purchases and Savings

Table 4-20 presents the estimated Invitation To Participate (ITP) Program energy savings based upon the input parameters as calculated at the time of the on-sites. The ITP Program is a buy down program with manufacturers and retailers that provides discounted prices on qualifying products at participating retailers without coupons. Although ITP purchases were not included in the on-site sample, we believe the input parameter results are appropriate for use for purposes of estimating gross savings estimates resulting from the ITP Lighting initiative. The number of products purchased was gathered from a summary of buy-down activity provided by EFI at the outset of the project. Calculating ITP gross impacts through use of the on-site input results provides an estimated 41.7 GWh of energy savings.

Table 4-20: 2003 ITP Energy Savings at the Time of the Onsite

Sponsor	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	All Lighting Types
Number of Products Purchased					
National Grid	802,138	38,619	4,423	16,246	861,426
NSTAR	310,807	11,627	1,473	4,183	328,090
Unitil	5,340	264	18	55	5,677
WMECo	92,688	13,207	1,842	2,586	110,323
Cape Light Compact	37,571	1,724	186	498	39,979
Total	1,248,544	65,441	7,942	23,568	1,345,495
KWh Energy Savings					
National Grid	23,714,578	1,102,817	488,003	1,390,506	26,695,904
NSTAR	9,188,764	332,025	162,521	358,026	10,041,335
Unitil	157,873	7,539	1,986	4,707	172,105
WMECo	2,740,248	377,144	203,234	221,337	3,541,962
Cape Light Compact	1,110,757	49,231	20,522	42,624	1,223,134
Total	36,912,219	1,868,755	876,265	2,017,201	41,674,441

a. includes specialty bulbs and standard bulbs.

b. includes desk lamps

Table 4-21 presents the ITP savings as calculated from an installation rate that assumes savings from customer-reported planned installations. If the installation rates include lighting that customers report they anticipate installing, the ITP savings estimate increases to nearly 56 GWh of savings.

Table 4-21: 2003 ITP Planned Energy Savings

Sponsor	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	All Lighting Types
Number of Products Purchased					
National Grid	802,138	38,619	4,423	16,246	861,426
NSTAR	310,807	11,627	1,473	4,183	328,090
Unitil	5,340	264	18	55	5,677
WMECo	92,688	13,207	1,842	2,586	110,323
Cape Light Compact	37,571	1,724	186	498	39,979
Total	1,248,544	65,441	7,942	23,568	1,345,495
KWh Energy Savings					
National Grid	32,261,065	1,366,629	528,976	1,421,406	35,578,076
NSTAR	12,500,299	411,450	176,166	365,982	13,453,897
Unitil	214,769	9,342	2,153	4,812	231,076
WMECo	3,727,804	467,362	220,297	226,256	4,641,720
Cape Light Compact	1,511,062	61,008	22,245	43,571	1,637,887
Total	50,214,999	2,315,791	949,836	2,062,028	55,542,655

a. includes specialty bulbs and standard bulbs.

b. includes desk lamps

5. On-Site Survey Findings

5.1. In-Home Data

Part of the on-site visits involved a brief survey and walk-through count of all lighting products installed in each customer's home. Out of the homes where loggers were installed, 116 surveys and 114 lighting inventory counts were performed. Some were not completed, either because of the customer's request or because the customer was not home to allow the auditor into the home (e.g., exterior fixture logger installations). This section summarizes the demographic results from the on-site survey and the lighting walk-through analysis.

Table 5-1 presents the age groupings and ownership of the homes in the on-site sample. Almost 83% of the homes in the sample were at least 20 years old and almost half were over 50 years old. A large majority (95.7%) of the homes in the sample were owned and almost 80% were between 1,000 and 3,000 square feet in size.

Table 5-1: Age, Ownership, and Size of Participant Homes

Age of Home (n=116)	
< 1 year	1.7%
1-5 years	1.7%
5-10 years	3.4%
10-20 years	9.5%
20-50 Years	33.6%
> 50 years	49.1%
Do Not Know	0.9%
Homeownership (n=116)	
Owner	95.7%
Renter, Pays for electricity	4.3%
Home Size (n=116)	
Less than 1,000	9.5%
1,000-1,500	25.9%
1,500-2,000	27.6%
2,000-3,000	25.9%
3,000-4,000	6.9%
4,000+	2.6%
Do Not Know	1.7%

Figure 5-1 shows the mix of bulb types found in the 114 homes where counts were performed. Slightly over 60% of the bulbs in these homes were incandescent. Compact fluorescent bulbs made up 26.3% of the bulbs found, while standard fluorescent and halogen bulbs accounted for 10.0% and 3.5%, respectively.

Figure 5-1: Participant Bulb Types

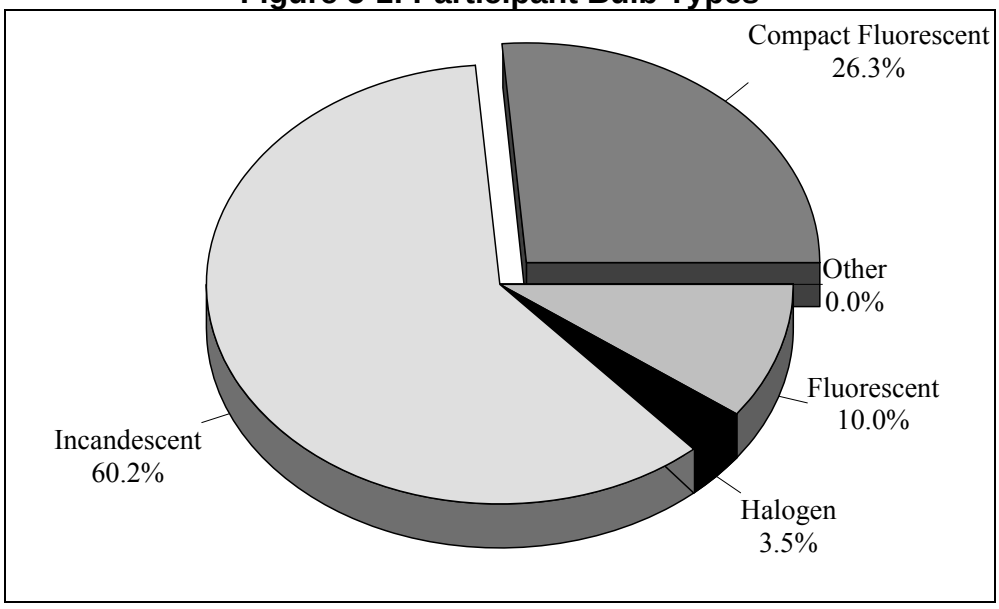


Table 5-2 presents the average number of bulbs from the on-site sample by room and bulb type. The average home had 54.6 bulbs, with 39.5 in conditioned spaces and 15.1 in unconditioned areas. By room type, bedrooms had the greatest number of sockets, with an average of 8.9, followed by living/family room/den, bathrooms, and basements, which averaged 8.2, 7.7, and 7.4, respectively.

By bulb type, the average home in the sample had 32.9 incandescent bulbs, 14.3 compact fluorescents, 5.5 standard fluorescents, and 1.9 halogens. It is important to note that although the number of homes with bulbs in each area is presented in Table 5-2, the averages were calculated using the entire sample size of 114 as the denominator.

Table 5-2: Average Number of Bulbs By Location and Type

	n	Mean
Total	**114**	**54.6**
By Area		
Interior	114	39.5
Exterior*	109	15.1
By Room		
Bedrooms	114	8.9
Living/Family Room/Den	114	8.2
Kitchen	111	5.2
Basements	90	7.4
Bathrooms	114	7.7
Hallway/Stairs	106	4.6
Dining Room	86	3.8
Laundry Room	12	0.2
Closets	43	1.0
Garage	49	1.6
Attic	17	0.5
Exterior	106	5.6
By Type		
Compact Fluorescent	114	14.3
Incandescent	111	32.9
Halogen	56	1.9
Standard Fluorescent	73	5.5
*Includes all unconditioned spaces such as garages, basements, & attics.		

As evident in Figure 5-2, newer homes tend to have more sockets, averaging 66.1 per home, compared to older homes, which have only 48.3 sockets on average.

Figure 5-2: Average Number of Bulbs By Age of Home

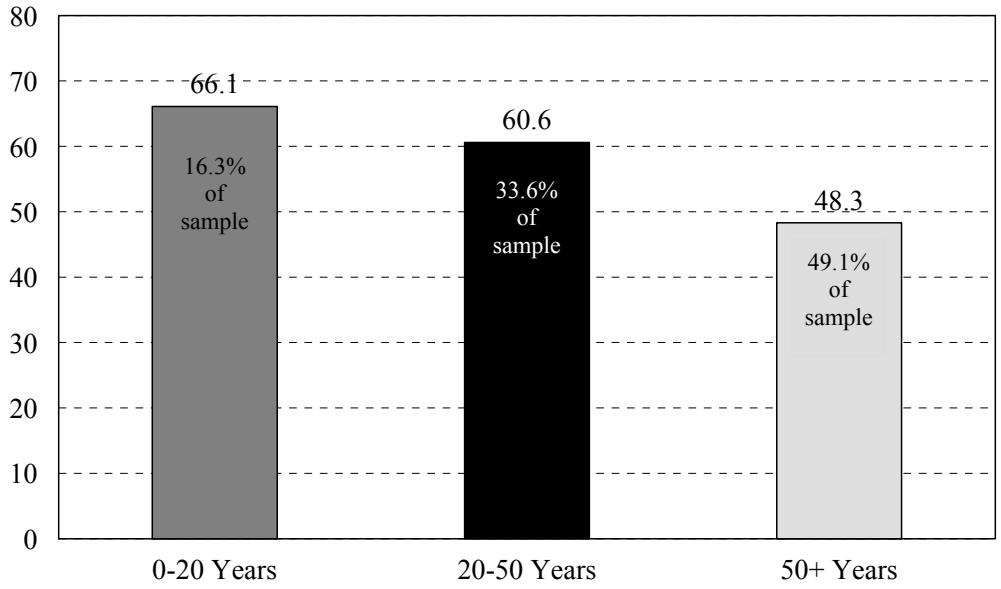
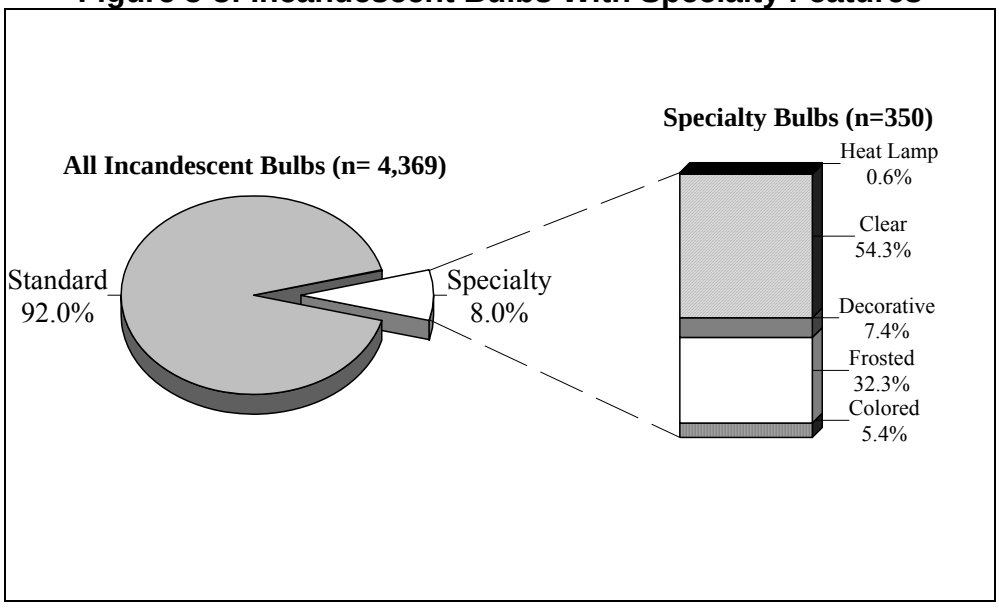


Figure 5-3 shows the potential for the replacement of incandescent bulbs with compact fluorescents from the on-site data. Only 8.0% of the incandescent bulbs found during the on-site visits cannot be replaced by a compact fluorescent. The most common incandescents found which do not have a compact fluorescent counterpart were clear bulbs and frosted bulbs; other types included decorative, colored, and heat lamps.

Figure 5-3: Incandescent Bulbs With Specialty Features



6. Telephone Survey Findings

This section presents results from the telephone survey of customers who participated in the 2003 RLP through catalog or using instant rebate coupon purchases.

Throughout this section, all reported sample sizes (n) are unweighted, while all percentages, sums, averages, and other results are weighted (unless otherwise noted) by population or total product sales. It is also important to note that respondents usually had the choice to respond "do not know" to most questions. Such responses affected estimates related to the total number of products and their usage so that amounts that theoretically should sum to the same number may not. For example, the total number of CFLs reported installed room by room exceeds the total number reported as installed. This results from the fact that at least some respondents who originally said they did not know how many total CFLs they installed (and thus could not be included in the estimate of the total number installed) later gave estimates of the number of installations in each room of the house. Likewise, the number of installations, removals, and products never installed will not always equal the total number of products purchased, again because of "do not know" responses. Other estimates are similarly affected. Outliers in the data set were identified by the inter-quartile range method and professional judgment.

6.1. Purchases, Installation, Removals, and Failure to Install

We used a two-step process to estimate the total number of products purchased in the telephone survey. First, we asked respondents if they remembered purchasing the number of products we had on record from the EFI database. If the respondent said yes, we recorded the number in the records as the actual number of products purchased. For those who said they purchased a different number of products, we recorded the number they recalled as the actual number purchased. Respondents who could not recall the number of products purchased were not included in estimates of total purchases, but they were still asked questions about installations, removals, and room-by-room use behavior.[18]

[18] Determining the actual number of products purchased through the program in a household can be problematic for a couple of reasons. First, program purchases may have been made more than once and variations in the way that coupons were filled out by participants—with slight differences in contact name (e.g. contact name listed as Bob Smith v. R. Smith), different members of the same household making a purchase, slight differences in address listings, and different phone numbers (e.g. home number v. mobile number) make aggregating customer records by household a difficult task. Secondly, respondent recollection of program purchases, particularly in the case of CFLs, where the number of products involved can be relatively large, may not be reliable.

Table 6-1 summarizes the unweighted number of products respondents recall purchasing through the RLP; it also weights their responses to the entire population of products purchased. As can be seen, CFLs were the most commonly purchased product type, followed by interior fixtures, torchieres, and exterior fixtures. As Table 6-2 shows, the vast majority of the non-ITP purchases were made through the instant rebate coupons. Note that 31% of exterior fixtures were purchased through the catalog; perhaps this is a function of the range of CFL fixture options that are available through the catalog as opposed to those available at retailers.

Table 6-1: Purchased through the 2003 RLP by Program

Coupon and Catalog purchases only; does not include ITP purchases

	n [a]			Unweighted Number Purchased			Weighted Number Purchased[b]		
	Total	**Coupon**	**Catalog**	**Total**	**Coupon**	**Catalog**	**Total**	**Coupon**	**Catalog**
CFLs	**398**	198	200	**1,629**	918	711	**167,788**	131,624	36,164
Torchieres	**192**	102	90	**306**	162	144	**10,554**	8,186	2,368
Interior	**315**	197	118	**627**	389	238	**38,207**	33,565	4,642
Exterior	**165**	84	81	**278**	135	143	**6,082**	4,198	1,884

[a] Those reporting that they did not purchase any products or cannot remember how many they purchased are excluded from the data.

[b] Weighted to the population of each product. For this question only, the weighted number purchased matches that derived for the population from the EFI database, minus any individuals with unusable data.

Table 6-2: Percentage of Products Purchased Through Coupon or Catalog

	Total Purchased	Coupon	Catalog
CFLs	167,788	78%	22%
Torchieres	10,554	78%	22%
Interior	38,207	88%	12%
Exterior	6,082	69%	31%

Table 6-3 summarizes the installed status of products purchased through the 2003 RLP as reported by survey participants. We asked respondents how many products were currently installed in their home. If all the products purchased were not currently installed, we asked respondents to estimate the number of products they had removed. The remainder represents the not-yet-installed products. The data show that, by far, most products have been installed (82% each for interior and exterior fixtures, 84% for CFLs, and 87% for torchieres). Relatively few products, never exceeding 5% (for torchieres), have been removed. Another sizable number of products remained uninstalled at the time of the survey (ranging from 9% for torchieres to 17% for exterior fixtures).

In comparing installation rates for coupon and catalog sales, we find no significant differences between the two sales channels for CFLs, torchieres, and interior fixtures. Install rates for catalog sales are slightly, but not significantly, higher than coupon sales for CFLs and interior fixtures sold through the program. However, the installation rate for exterior fixtures sold with instant rebate coupons is significantly higher than for those sold through the catalog; conversely, 28% of exterior fixtures sold through the program have not yet been installed, compared to only 10% of products sold through coupons.

Table 6-3: Number Installed, Removed, or Not Yet Installed by Program and Product

		Total Program			Coupon			Catalog		
		Installed	**Removed**	**Not Yet Installed**	**Installed**	**Removed**	**Not Yet Installed**	**Installed**	**Removed**	**Not Yet Installed**
CFLs	**n**	**407**	**80**	**84**	203	50	40	204	30	44
	% of Program	82%	3%	15%	80%	3%	17%	84%	4%	12%
Torchieres	**n**	**194**	**30**	**23**	104	15	11	90	15	12
	% of Program	86%	5%	9%	86%	6%	8%	85%	4%	11%
Interior	**n**	**328**	**54**	**41**	206	35	26	122	19	15
	% of Program	85%	3%	12%	85%	2%	12%	88%	3%	9%
Exterior	**n**	**172**	**37**	**32**	86	12	9	86	25	23
	% of Program	79%	4%	17%	85%[d]	5%	10%	69%	3%	28%

[a] Weighted to the population of each product.
[b] Asked only of those who had not installed all the CFLs purchased.
[c] Applies only to participants who had not installed or removed all the CFLs purchased.
[d]Significantly different from catalog at the 90% confidence level.

Looking at the very small number of respondents who removed products, we find CFL buyers typically either threw products away or put them away for future use. (Table 6-4) Fixture buyers who removed products typically either put them away for future use or returned them; however a sizable number of respondents threw away the interior fixtures they removed. (Table 6-5). Future savings are likely to be achieved through products put away for future use.

Table 6-4: What Respondent Did with Products that were Removed

(all respondents who removed one or more products, number of multiple responses)[a]

	CFLs	Torchieres	Interior Fixtures	Exterior Fixtures
n	**38**	**8**	**16**	**9**
Threw away	20	1	4	1
Put away	14	3	4	3
Returned to catalog vendor	2	0	1	0
Returned to retailer	0	2	3	0
Gave away	0	1	1	0
Recycled	1	0	0	0
Don't know	1	1	3	5

[a] The data represent the actual number of respondents reporting each action and are not weighted due to the small number of respondents reporting that they removed products. Because respondents could name multiple actions, the totals may exceed the sample size (n).

As Table 6-5 shows, the primary reason for removal of CFLs is due to bulb burn-out or breakage; factors associated with the quality, color, and output of light are also cited as reasons for removal. For fixtures, the appearance of the product itself and factors associated with the quality, color, and output of light are cited as reasons for removal.

Table 6-5: Reasons Named for Removal of Energy-Efficient Lighting Products Purchased through the RLP

(all respondents who removed one or more products, number of responses reported, multiple response)[a]

	CFLs	Torchieres	Interior Fixtures	Exterior Fixtures
n	**38**	**8**	**16**	**9**
Burned out	11		1	2
Bulb not bright enough	8		3	1
Don't like quality of light	2	3	5	
Broke	5	2	1	1
Don't like appearance/style of bulb or fixture		1	5	2
Bulb too bright	5	1	1	
Light beginning to dim	3	1		
Bulb doesn't fit/Could not install properly	3			
Doesn't save energy	3			
Flickers	2		1	
Delay in light coming on	2			1
Doesn't work with/wanted dimmer, 3-way switch	1	1		
Don't like color of light		1		
Interference with electronics				1
Bulbs were hot		1		
Under construction				1
Caused a fire			1	
Don't Know[b]	1	1	2	2

[a] Number of responses shown due to small sample sizes. Data are not weighted.
[b] Reported as the number of respondents responding "Don't Know" as primary reason only.

Most respondents who had not yet installed the products they purchased through the 2003 RLP put the products away for use at a later time—indicating future savings are likely to be achieved through these products. Table 6-6 shows that a small number of products were returned to the catalog vendor or retailer, or in the case of CFLs, thrown away. As noted in Table 6-7, torchieres are sometimes purchased as a gift or for use in an office; however, the final destination for these products was not identified, so attribution of the future savings to the Sponsors can not be determined.

Table 6-6: What Respondents Did with Products Never Installed

(all respondents who did not install one or more products, number of multiple responses)

	CFLs	Torchieres	Interior Fixtures	Exterior Fixtures
n	**84**	**23**	**43**	**32**
Put away	77%	28%	60%	60%
Threw away	17		7	7
Returned to catalog vendor	3		1	
Returned to retailer	1	11	6	8
Gave away	<1	19	5	7
Took to office/work		17		
Don't know	1	2	21	18

Among those who had not yet installed the products purchased through the 2003 RLP, 41% of CFL buyers, 27% of interior fixture buyers, and 23% of exterior fixture buyers say they bought them as spares or haven't gotten around to installing them yet; an additional 11% of exterior fixture buyers say they need help installing them. These reasons all point to likely future energy savings from the products once they are put to use. However, almost 15% of CFL buyers who have not installed the bulbs cite some form of dissatisfaction with the product, including 9% who say they were not satisfied with the light quality. Similarly, about 15% of interior fixture buyers who have not installed the fixtures cite some form of dissatisfaction with the product, and while the n's are small, a large portion (35%) of exterior fixture buyers say the fixture was broken. In addition, many torchiere buyers (21%) bought the torchiere as a gift and 9% bought the torchiere to take to the office. (Table 6-7)

Table 6-7: Reasons for Not Installing Products Purchased through the RLP

(all respondents who did not install one or more products, multiple response)[a]

	CFLs	Torchieres	Interior Fixtures	Exterior Fixtures
n	84	23	41	32
Bought as spares	32%	<1%	6%	5%
Only recently received/haven't gotten around to it	9	8	21	18
Not satisfied with light quality	9			
Didn't fit fixture/ location for which intended	2	6	2	8
Didn't work with 3-way or dimmer	1		4	
Broken	1		1	35
Returned for a better price	1			
Bought as gifts	<1	21	3	4
Bulb too heavy for fixture	<1			
Didn't like way it looked/style		5	3	
Changed mind about it		4	5	3
Need help installing			3	11
Decided to exchange it		3		
Bought to take to office		9		
Don't know [b]	4	16	31	22

[a] Weighted to the population of program participants.

[b] Reported as the number of respondents responding "Don't Know" as primary reason only.

Intended Use of the Products Purchased through the RLP

We asked buyers of CFLs how they decide to use them. Over half (56%) of the respondents purchasing CFLs consider the most basic lighting need in deciding where to install the bulbs—that is, they put the CFLs where another bulb had burned out or where they needed a light. (Table 6-8) However, a majority of buyers also consider at least one of the attributes of CFLs in their installation decision: 27% install CFLs where lights are left on for long time periods, 12% put CFLs where they want a long-life bulb, 7% put them in hard to reach fixtures, and 8% put CFLs anywhere except in fixtures on dimmer or three-way switches. Six percent of respondents place CFLs wherever they do not currently have one installed. The few other responses volunteered by respondents include placing the CFL where it fits, where it saves the most money, outside the house or where motion detectors are used, and where it cannot be seen.

Table 6-8: How Respondents Decided Where to Install CFLs
(all who indicate that they purchased CFLs, multiple response)[a]

n	**407**
Wherever a bulbs had burned out or needed a light	56%
Where lights left on for long time periods	27
Where wanted a long-life bulb	12
Anywhere except in fixtures on dimmer switch/3-way switch	8
In hard-to-reach fixtures	7
Wherever a CFL is not currently installed	6
Other	2
Don't know	6

[a] Weighted to the population of program participants.

The majority of respondents purchased products to replace existing bulbs or fixtures, ranging from 70% for exterior fixtures to 99% for CFLs. As Table 6-9 shows, 88% of CFL buyers replaced incandescent bulbs and 11% replaced other CFLs.

Table 6-9: CFLs Installed to Replace Existing Bulbs or to Put into New Fixtures

(all respondents installing CFLs)

	Replace Incandescent Bulbs	Replace Another CFL	New Fixture
n	382	382	382
0[a]	7%	89%	97%
1[a]	15	3	2
2-5[a]	43	6	1
6-10[a]	32	1	0
More than 10[a]	1	<1	0
Don't know[a]	1	1	0
Total Number[b]	123,070	15,272	2,185
% of Products Installed	88%	11%	2%

[a] Weighted to the population of program participants
[b] "Don't Know" responses removed from total. Weighted to the population of CFLs

Of the CFLs that replaced other CFLs, the majority of respondents put them in high-use areas of the home—hall/foyer (16%), bathroom (13%), and kitchen (10%), dining room (9%), living room (8%), and exterior (5%). (Table 6-10)

Table 6-10: Type of Products Respondents Replaced with CFLs by Room

(all respondents who replaced existing bulbs with CFLs, multiple response)[a]

	n	Incandescent	Another CFL
Living Room	247	91%	8
Kitchen	107	91%	10
Dining Room	26	86%	9
Hall/Foyer	72	86%	15
Bedroom	96	94%	4
Bathroom	37	81%	13
Garage	11	95%	5
Exterior/Outside	38	95%	5
Closet	4	91%	9
Utility Room	11	95%	5
Basement	40	93%	6
Office	4	95%	5

[a] Weighted to the population of program participants. The survey asked respondents to indicate what, if any, type of bulb was replaced by a CFL, but did not count the number of bulbs for each replacement. Totals may not equal 100% due to multiple responses and "don't know" and "new light source" responses.

As Table 6-11 through Table 6-13 shows the majority of fixtures purchased through the 2003 RLP also replaced existing fixtures, but many were purchased as new light sources for existing space in the home: 14% for interior fixtures, 18% for torchieres, and 19% for exterior fixtures. No more than 8% (for exteriors) of any fixture type was intended for a new home or addition.

Table 6-11: Torchieres Installed to Replace Existing Lamps or as a New Fixture

(all respondents installing Torchieres)

	Replace Existing Lamp	New Lamp in Existing Room	Lamp in a New Home or Addition
n	**178**	**178**	**178**
0	17%	81%	95%
1	60	13	3
2-5	22	5	1
Don't know	1	1	1
Total Number[b]	7,059	1,672	254
% of Products Installed	77%	18%	3%

[a] Weighted to the population of program participants.
[b] "Don't Know" responses removed from total. Weighted to the population of torchieres.

Table 6-12: Interior Fixtures Installed to Replace Existing Lamps or as a New Fixture

(all respondents installing Interior Fixtures)

	Replace Existing Lamp	New Lamp in Existing Room	Lamp in a New Home or Addition
n	**299**	**299**	**299**
0	20%	83%	91%
1	50	12	5
2-5	27	3	3
More than 5	3	1	0
Don't know	2	1	1
Total Number[b]	24,460	4,470	1,982
% of Products	78%	14%	6%

[a] Weighted to the population of program participants.
[b] "Don't Know" and other unusable responses removed from total. Weighted to the population of interior fixtures.

Table 6-13: Exterior Fixtures Installed to Replace Existing Lamps or as a New Fixture

(all respondents installing Exterior Fixture)[a]

	Replace Existing Exterior Fixture	New Fixture Where Was Not One Before	Fixture in a New Home or Addition
n	**147**	**147**	**147**
0	22%	75%	87%
1	50	16	5
2-5	24	3	2
More than 5	0	1	0
Don't know	4	6	6
Total Number[b]	3,449	932	379
% of Products	70%	19%	8%

[a] Weighted to the population of program participants.
[b] "Don't Know" responses removed from total. Weighted to the population of exterior fixtures.

As with CFLs, most of the fixtures purchased in the 2003 RLP are being used to replace fixtures that used less efficient incandescent or halogen bulbs (Table 6-14 through Table 6-16). Fifty-four percent of torchieres are being used to replace fixtures that had used incandescent bulbs and another 34% are replacing fixtures with halogen bulbs. Of the torchieres that replaced existing fixtures, 62% replaced units with a dimmer or three-way switch. Typically, respondents report using the dimmer or three-way switch on the brightest setting 61% of the time, the medium setting 20% of the time, and the lowest setting 19% of the time. The savings estimates in this report assume the brightest setting for torchieres as information on the number and use of dimmable torchieres was not gathered in the on-sites. Likewise, most interior and exterior fixtures are replacing existing ones that used incandescent bulbs. However, 10% of interior fixtures are replacing fluorescent tubes and another 10% are replacing existing fixtures using CFLs. Similarly, 17% of exterior fixtures are replacing fluorescents, and another 13% are replacing CFLs.

Table 6-14: Number of Torchieres that Replaced Fixtures that used Each Type of Bulb

(all respondents replacing lamps with torchieres)[a]

n	**146**	
	Total Number	**%**
Incandescent bulb	3,643	54%
Halogen bulb	2,314	34
CFL	823	12
Other	31	<1

[a] Weighted to the population of torchieres.

Table 6-15: Number of Interior Fixtures that Replaced Fixtures that used Each Type of Bulb

(all respondents replacing lamps with Interior Fixture)[a]

n	**240**	
	Total Number	**%**
Incandescent bulb	17,557	74%
Fluorescent tubes	2,464	11
Halogen bulb	725	3
CFL	2,444	10
Other	259	1

[a] Weighted to the population of interior fixtures.

Table 6-16: Number of Exterior Fixtures that Replaced Fixtures that used Each Type of Bulb

(all respondents replacing lamps with Exterior Fixture)[a]

n	115	
	Total Number	**%**
Incandescent bulb	2,131	65%
Fluorescent tubes	564	17
Halogen bulb	161	5
CFL	409	13

[a] Weighted to the population of exterior fixtures.

The greatest potential savings from energy-efficient lighting products comes from situations where they replace higher wattage products in high-use areas of the home. We asked respondents to recall how many CFLs, torchieres, and interior fixtures were installed in various rooms of their homes (asked in random order). As Table 6-17 shows, all products were installed most frequently in the living room, a high-use area of the home. Interior fixtures and CFLs were frequently placed in the kitchen, hall, and bathroom, also high-use rooms and places where people may desire long-life products. Many CFLs, torchieres, and interior fixtures were also installed in bedrooms. Likewise, many CFLs were also placed on the exterior of the house or in the basement. Customers, then, appear to be placing products in places where lighting products are used most frequently or where a long-lived product would be useful.

Table 6-17: Number of Products Installed in Each Room

(all respondents installing products)

	High-Use Area [a]	**CFLs**		**Torchieres**		**Interior Fixtures**	
		# of Respon-dents	**# of Products**	**# of Respon-dents**	**# of Products**	**# of Respon-dents**	**# of Products**
Living Room	√	309	52,731	128	5,308	153	11,490
Kitchen	√	184	21,945	15	155	75	5,549
Bedroom		131	19,190	50	2,655	57	5,221
Hall/Foyer	√	141	14,206	12	111	43	3,613
Basement		49	9,632	8	440	10	895
Dining Room	√	122	6,033	19	422	27	856
Bathroom	√	71	6,755	2	0	14	1,462
Exterior/Outside	√	53	5,954	NA	NA	NA	NA
Garage		43	1,710	3	49	4	486
Utility Room		27	1,269	3	155	7	622
Closet		23	407	3	49	7	613
Office		4	440	7	204	5	362
TV room		0	0	1	31	0	0
Porch/Sunroom							

[a] As defined by the ENERGY STAR Advanced Lighting Package program specifications.

Wattage Replaced By and Comparative Use of Products Purchased Through the RLP

We also asked respondents to estimate the average wattage that had been replaced by the energy-efficient products purchased through the RLP. We specifically asked them to provide an average of all bulbs replaced by CFLs. For torchieres and interior fixtures we also asked the respondent to consider the total wattage of each fixture or lamp in the room. Thus, if a respondent had replaced two floor lamps in the living room, one with three bulbs of 60 watts each (180 total) and one with two bulbs of 75 watts each (150 total), this respondent should have said that the new efficient fixtures they purchased replaced 165 watts. This question obviously leaves room for respondent error, because they respondent first must think about what was replaced, then remember the wattage of each bulb in each fixture replaced, and then take an average. This is difficult for respondents to accomplish while responding to a phone survey. The potential difficulties with this measure are compounded by the relatively small sample sizes found in many rooms. Thus, the discussion of the wattages replaced by products purchased through the RLP (Tables 6-18 through 6-20) should be evaluated with these considerations in mind.

Table 6-18 provides an estimate of the wattage of *individual bulbs or fixtures replaced* by a product purchased through the RLP. CFLs replaced other bulbs ranging from an average of 59 watts in the bathroom, where multiple low-wattage bulbs may be used, to a high of 83 watts in the utility room. The wattage replaced by torchieres ranged from 60 watts to 237 watts, depending on room. These wattages reflect the findings from Table 6-14, which show that over half of torchieres replaced fixtures with incandescent bulbs and just over a third of torchieres replaced fixtures with halogen bulbs. In contrast, the smaller average wattages for interior fixtures (ranging from 33 watts to 97 watts) reflects findings from Table 6-15, which shows 66% of interior fixtures replacing fixtures with incandescent bulbs and another 30% replacing a mix of fixtures with fluorescent tubes and CFLs.

Table 6-18: Average Wattage of Products Replaced in Each Room

(all respondents replacing existing products in each room)[a]

	CFLs		Torchieres		Interior Fixtures	
	n[b]	Ave. Watts per Bulb Replaced[c]	n[b]	Ave. Watts per Fixture Replaced[c]	n[b]	Ave. Watts per Fixture Replaced[c]
Living Room	239	80	106	153	103	86
Kitchen	107	70	3	145	50	97
Dining Room	25	72	9	237	11	61
Hall/Foyer	72	69	2	75	36	71
Bedroom	96	66	38	168	48	72
Bathroom	35	59	0	0	11	74
Garage	11	66	0	0	2	60
Exterior/Outside	36	60	NA	NA	NA	NA
Closet	4	64	1	60	5	33
Utility Room	11	77	2	70	5	45
Basement	40	63	4	175	8	87
Office	3	77	7	150	4	48
TV Room	0	0	1	150	0	0

[a] Weighted to the population of each product.
[b] Sample size (n) reflects the number of people asked who did not respond that the product was a "new light source."
[c] "Don't know" responses excluded from averages.

While the data in Table 6-18 provide an estimate of the per-product wattage replaced, those in Table 6-19 and Table 6-20 instead offer approximations of the *total and average wattage replaced by room or home exterior* for all CFLs and exterior fixtures installed. The survey data allowed us to compute such estimates only for the CFLs and exterior fixtures. To arrive at these estimates, we multiplied the average wattage replaced in each room by the total number of products installed in each room. This gives us the total wattage replaced (presented in Table 4-19 in thousands of watts). This total wattage is then divided by the number of rooms in which products were installed to provide an estimate of the average wattage replaced by room or home exterior.

Looking at CFLs, we find that that the greatest number of watts was saved in the living room: 3,741,000 watts for an average of 195. The average wattage replaced in most rooms (except the "other" category) range from 100 to 145 watts. Exterior fixtures replaced 186,142 watts, an average of 104 for each house. In addition, the average wattage replaced on the exterior of homes by both CFLs and exterior fixtures is quite close—107 and 104 respectively—providing some assurance of the reliability of the data.

Table 6-19: Total and Average Wattage of Products Replaced by CFLs in Each Room

(all respondents replacing existing products in each room)[a]

	n[b]	Total Watts Replaced (in thousands)[c]	Average Watts Replaced per Room[c]
Living Room	239	3,741	195
Kitchen	107	1,397	143
Dining Room	25	113	103
Hall/Foyer	72	744	131
Bedroom	96	991	125
Bathroom	35	356	114
Garage	11	96	112
Exterior/Outside	36	272	110
Closet	4	36	150
Utility Room	11	106	139
Basement	40	556	140
Office	3	47	64

[a] Weighted to the population of each product.
[b] Sample size (n) excludes those who said that the product was a "new light source."
[c] "Don't know" responses excluded from estimates of total and average wattage.

Table 6-20: Average and Total Wattage of Products Replaced by Exterior Fixtures

(all respondents replacing exterior fixtures with energy-efficient models)[a]

n[b]	115
Total Wattage Replaced[c]	186,412
Average Wattage Replaced[c]	104

[a] Weighted to the population of each product.
[b] Sample size (n) excludes those who said that the product was a "new light source."
[c] "Don't know" responses excluded from estimates of total and average wattage.

The majority of respondents report that they use the energy-efficient lighting products purchased through the 2003 RLP to the same extent as the ones that were replaced; the remainder tend to report using the products more. (Table 6-21 through Table 6-24) Exceptions to these patterns, other than for CFLs installed on the exterior of the house, occur when sample size is small and will not be discussed in more detail. More specifically, in most rooms at least three out of four respondents say they use CFLs to the same extent as the bulb that was replaced. However, 51% of those installing CFLs on the exterior of the house say they use the products more than the one it replaced. This may reflect the fact that respondents are more likely to keep the lower-cost CFLs on all night instead of turning them off before going to bed.

Torchieres are typically used to the same extent by 50% to 100% of respondents for each room, and interior fixtures by about 75% to 100% of respondents. Exterior fixtures are used to the same extent by 62% of respondents. Almost all other respondents recall using the new products more than the ones they replaced, with percentages tending to fall near the 10-25% range.

Table 6-21: Use of New CFLs Compared to Bulbs that were Replaced
(all respondents replacing existing bulbs)[a]

	n	More than one replaced	More than one replaced but instead of others	To the same extent as the one replaced	Less than the one replaced	Don't Know
Living Room	239	21%	4	72	0	3
Kitchen	107	7%	3	87	0	3
Dining Room	25	7%	0	87	6	0
Hall/Foyer	72	12%	<1	82	4	3
Bedroom	96	22%	1	73	2	2
Bathroom	35	18%	1	75	0	6
Garage	11	1%	0	99	0	0
Exterior/Outside	36	51%	5	39	4	2
Closet	4	56%	0	44	0	0
Utility Room	11	13%	0	86	0	2
Basement	40	2%	<1	96	2	0
Office	3	0	0	100	0	0

[a] Weighted to the population of program participants.

Table 6-22: Use of New Torchieres Compared to Products that were Replaced

(all respondents replacing existing torchieres or interior fixtures)[a]

	n	More than one replaced	More than one replaced but instead of others	To the same extent as the one replaced	Less than the one replaced	Don't Know
Living Room	106	23%	2	68	5	3
Kitchen	3	0%	0	67	33	0
Dining Room	9	19%	0	81	0	0
Hall/Foyer	2	0%	0	42	0	58
Bedroom	38	13%	0	82	4	0
Closet	1	0%	0	100	0	0
Utility Room	2	50%	0	50	0	0
Basement	4	20%	0	80	0	0
Office	7	22%	0	65	4	10
TV Room	1	0%	0	100	0	0

[a] Weighted to the population of program participants.

Table 6-23: Use of New Interior Fixtures Compared to Products that were Replaced

(all respondents replacing existing interior fixtures) [a]

	n	More than one replaced	More than one replaced but instead of others	To the same extent as the one replaced	Less than the one replaced	Don't Know
Living Room	102	12%	0	83	2	3
Kitchen	50	13%	2	78	5	3
Dining Room	11	11%	15	75	0	0
Hall/Foyer	36	16%	0	80	1	3
Bedroom	48	2%	1	83	12	3
Bathroom	11	4%	8	88	0	0
Garage	2	87%	0	13	0	0
Closet	7	0%	0	100	0	0
Utility Room	7	0%	0	77	0	23
Basement	10	13%	0	87	0	0
Office	5	0%	0	100	0	0

[a] Weighted to the population of program participants.

Table 6-24: Use of New Exterior Fixtures Compared to Products that were Replaced

(all respondents replacing existing exterior fixtures) [a]

n	**115**
More than one replaced	19%
More than one replaced but instead of others	11
To the same extent as the one replaced	62
Less than the one replaced	5
Don't Know	3

[a] Weighted to the population of program participants.

Hours Products Used and Whether Left On or Used as Needed

Table 6-25 shows the overall average daily use per unit purchased for each product and compares the telephone survey results to the on-site survey results. For survey respondents, these estimates are based on the sum of total number of hours used for each product installed across rooms, divided by the total number of products. The on-site estimate is based on the sum of the total number of hours each product is used per day, divided by the number of products logged for each product type. Exteriors for both survey and on-site estimates are the number of products reported installed.

Table 6-25: Overall Average Daily Use by Product

(Hours used per day)

	Telephone Summer	**Telephone Winter**	**On-site**
CFLs	4.1	5.3	2.6
Torchieres	2.9	4.4	2.5
Interiors	3.0	4.0	2.1
Exteriors	4.8	6.3	4.0

To derive the telephone survey estimates in Table 6-25, we asked respondents to estimate for each room, on average, how many hours of the day they typically used the products purchased through the 2003 RLP in both summer and winter months. In order to account for multiple installations and provide a more complete accounting of usage, we multiplied the average hours customers say they use products in each room by the total number of products installed in that room. Therefore, if a program participant is using four CFLs for eight hours a day, that person is using an equivalent of 32 "bulb hours" each day.

Table 6-26 through Table 6-31 summarize the analyses of the overall hourly usage of CFLs and fixtures purchased through the 2003 RLP. In all cases, respondents follow logic, reporting that winter use is equal to or exceeds summer use, again providing some assurance of the reliability of the data. Respondents also tend to report using CFLs and fixtures more in typically high-use areas of the house—the exterior of the house, living rooms, halls and foyers; they also report high usage in utility rooms and basements. Torchieres follow a similar pattern to CFLs, but purchasers of interior fixtures also report using the product for longer periods of time in kitchen, garages, and "other" rooms. The actual number of average summer hour products used ranges from one (a torchiere in the closet) to 15 (CFLs in the hall and on the exterior of the house). Winter hours range from one (again the torchiere in the closet) to 18 (CFLs in the hall). Exterior fixtures are used, on average, nine hours in the summer and eleven hours in the winter, somewhat less than that reported for exterior CFLs. However, this may be explained by the fact that exterior fixtures—energy efficient or not—often have more than one bulb, increasing the number of "bulb hours" CFLs would be used outside.

Table 6-26: Total and Household Average Hours Products Used in the Summer by Program and Product[a]

	Total			Coupon			Catalog		
	n	Hours	House Ave.	n	Hours	House Ave.	n	Hours	House Ave.
CFLs	357	583,861	17.3	186	470,702	18.8	171	113,159	13.0
Torchieres	164	26,620	4.8	83	19,878	4.7	81	6,743	4.9
Interior	269	100,214	6.0	172	89,070	6.0	97	11,144	5.5
Exterior	122	24,167	8.6	67	17,633	8.4	55	6,535	9.4

[a] Weighted to the population of each product. "Don't know" responses removed.

Table 6-27: Total and Household Average Hours Products Used in the Winter by Program and Product[a]

	Total			Coupon			Catalog		
	n	Hours	House Ave.	n	Hours	House Ave.	n	Hours	House Ave.
CFLs	358	752,075	22	185	593,008	23.8	173	159,067	18.0
Torchieres	166	41,042	7.2	87	30,952	7.0	79	10,090	7.5
Interior	270	131,186	7.8	171	116,191	7.9	99	14,995	7.3
Exterior	123	31,168	11.2	65	21,931	10.7	58	9,237	12.7

[a] Weighted to the population of each product. "Don't know" responses removed.

Table 6-28: Total and Average Hours CFLs Used in Summer and Winter by Room

(all respondents installing CFLs)[a]

		SUMMER HOURS		WINTER HOURS	
	n	**Total per Room[b]**	**Average per Room[b]**	**Total per Room[b]**	**Average per Room[b]**
Living Room	247	204,753	10	277,082	13
Kitchen	107	82,269	8	110,475	11
Dining Room	26	16,287	6	24,006	9
Hall/Foyer	72	102,128	15	122,787	18
Bedroom	96	54,854	6	82,316	9
Bathroom	37	15,121	5	17,577	5
Garage	11	2,517	3	3,041	3
Exterior/Outside	38	46,486	14	53,485	17
Closet	4	1,455	6	1,4,55	6
Utility Room	11	8,130	10	8,130	10
Basement	40	38,731	10	43,285	11
Office	4	3,901	4	4,416	5

[a] Weighted to the population of CFLs.
[b] "Don't Know" responses removed from totals and averages.

Table 6-29: Total and Average Hours Torchieres Used in Summer and Winter by Room

(all respondents installing torchieres)[a]

		SUMMER HOURS		WINTER HOURS	
	n	**Total per Room[b]**	**Average per Room[b]**	**Total per Room[b]**	**Average per Room[b]**
Living Room	123	16,283	4	26,192	7
Kitchen	4	497	4	590	5
Dining Room	11	1,087	4	1,838	6
Hall/Foyer	3	481	4	606	5
Bedroom	49	7,209	4	9,743	6
Garage	1	197	4	197	4
Closet	1	49	1	49	1
Utility Room	2	528	9	808	13
Basement	7	862	3	1,318	5
Office	7	457	2	711	3
TV Room	1	62	2	93	3

[a] Weighted to the population of torchieres.
[b] "Don't Know" responses removed from totals and averages.

Table 6-30: Total and Average Hours Interior Fixtures Used in Summer and Winter by Room

(all respondents installing interior fixtures)[a]

		SUMMER HOURS		WINTER HOURS	
	n	Total per Room[b]	Average per Room[b]	Total per Room[b]	Average per Room[b]
Living Room	129	45,600	7	57,965	8
Kitchen	62	17,981	5	26,701	8
Dining Room	14	2,434	3	3,972	5
Hall/Foyer	42	7,547	3	9,622	5
Bedroom	56	13,126	4	15,976	5
Bathroom	14	1,553	3	2,071	4
Garage	3	1,211	6	1,593	8
Closet	7	856	2	960	3
Utility Room	7	903	2	1,242	3
Basement	10	1,632	3	2,133	4
Office	5	1,657	6	2,175	8

[a] Weighted to the population of interior fixtures.
[b] "Don't Know" responses removed from totals and averages.

Table 6-31: Average Hours Exterior Fixtures Used in Summer and Winter

(all respondents installing exterior fixtures)[a]

n=147	Total Hours Used[b]	Average Hours Used[b]
Summer Hours	23,861	9
Winter Hours	31,279	11

[a] Weighted to the population of exterior fixtures.
[b] "Don't Know" responses removed from totals and averages.

The impact of the 2003 RLP program is also affected by whether respondents leave the product on once it has been turned on or whether they turn the product on and off as needed. For example, someone may turn on the living room light upon returning home from work for the day and leave it on until going to bed, even if the living room is not being used. Another may turn the light on and off only when in the room. Again, with only a few logical exceptions or those potentially resulting from small sample sizes, respondents overwhelmingly report that they use lights as needed. It should be noted that there is a potential for social desirability bias for these responses; some respondents may have responded in a way that would make them appear to be conscientious about their lighting usage. (Table 6-32 through Table 6-35) CFLs are left on in greater number on the exterior of the house, in utility rooms, and in "other" rooms. Exterior fixtures are left on by 17% of respondents, turned on and off as needed by 40%, and used on a photocell by another 40%.

Table 6-32: Are CFLs Left On or Turned On and Off as Needed?

(all respondents installing CFLs)[a]

	n	Left On	Used as Needed	Don't Know
Living Room	247	22%	76	2
Kitchen	107	15%	85	0
Dining Room	26	39%	61	0
Hall/Foyer	72	36%	64	0
Bedroom	96	9%	91	0
Bathroom	37	6%	88	6
Garage	11	0%	100	0
Exterior/Outside	38	58%	42	<1
Closet	4	0%	100	0
Utility Room	11	34%	66	0
Basement	40	2%	98	0
Office	4	95%	5	0

[a] Weighted to the population of program participants.

Table 6-33: Are Torchieres Left On or Turned On and Off as Needed?

(all respondents installing Torchieres)

	n	Left On	Used as Needed	Don't Know
Living Room	123	23%	75	2
Kitchen	4	0%	100	0
Dining Room	11	30%	70	0
Hall/Foyer	3	0%	100	0
Bedroom	49	7%	93	0
Garage	1	0%	100	0
Closet	1	100%	0	0
Utility Room	2	0%	100	0
Basement	7	15%	85	0
Office	7	0%	90	10
TV Room	1	0%	100	0

[a] Weighted to the population of program participants.

Table 6-34: Are Interior Fixtures Left On or Turned On and Off as Needed?
(all respondents installing Interior Fixtures)

	n	Left On	Used as Needed	Don't Know
Living Room	129	18%	78	3
Kitchen	62	13%	87	<1
Dining Room	14	23%	77	0
Hall/Foyer	42	24%	70	5
Bedroom	56	9%	91	0
Bathroom	14	0%	100	0
Garage	3	0%	100	0
Closet	7	18%	82	0
Utility Room	7	0%	100	0
Basement	10	19%	81	0
Office	5	5%	95	0

[a] Weighted to the population of program participants.

Table 6-35: Are Exterior Fixtures Left On or Turned On and Off as Needed?
(all respondents installing Exterior Fixtures)

n	147
Left On	17%
Used as Needed	40
On Timer or Photocell	42
Don't Know	2

[a] Weighted to the population of program participants.

Use of Lighting During Extended Periods Away From Home

Sponsors of this evaluation were interested in determining the extent to which customers used lights while they were away from home for extended periods of time, speculating that so called "snowbirds" who spend time away from their homes in winter, and others like them, continue to use lighting for security purposes. We asked respondents if they were typically away from home for more than one month at a time; a very small number, 1.3%, say they are away during the winter season and slightly fewer (0.7%) are away for an extended period during the summer season. (Table 6-36)

On-site surveys confirm that the number of people away for extended periods of time is small—only one of the on-site survey participants said they were away from home for any extended period of time during the year. Given the fact that the survey was administered in late April/early May, it is possible that some "snowbirds" had not yet returned from a winter away, and thus were not included in the survey, but that number is likely to be small. It is also possible that the sensitive nature of asking people about their living patterns in a survey format leads to response bias to the question—and thus may undercount the actual number of people away from home for extended periods of time.

Table 6-36: Time of Year Away From Home for More Than 1 Month

(all respondents, multiple response)

n	823
Spring	<1%
Summer	1
Fall	<1
Winter	1
Not away from home	93
DK/Refused	5

[a] Weighted to the population of program participants

Due to the small number of respondents who are away from home for extended periods during the year, it is difficult to make conclusive statements about their lighting use patterns; however, Table 6-37 shows that when away from home, the majority of respondents continue to use lighting to some extent. Most use lights intermittently, with a tendency to put lights on a timer, use lights with a photocell, or have someone turn them on; a smaller number leave some lights on all of the time.

Table 6-37: Are Interior Fixtures Left On or Turned On and Off as Needed?

(all respondents away from home for extended periods;
actual n's reported, except for Total, which is weighted
to the population of program participants)

	Spring	**Summer**	**Fall**	**Winter**	**Total**
Keep some lights on	1		1	2	10%
Use a timer or photocell	1	6		5	51%
Have someone turn them on and off		1		1	9%
No lights are on			1	3	31%

7. Assessment of Measure Life

Due to limitations in the data currently available through PEARL and other sources, we cannot recommend any definitive adjustments to assessing measure life at this time. In this section we review related information and offer an indication of the extent to which products sold through the 2003 RLP may be a concern due to their loss of ENERGY STAR status. However, we note that the reasons for products failing to maintain their ENERGY STAR status may be varied; this analysis provides only an indication of the potential ceiling for the number of products that potentially have measure life problems.

Assessment of Measure Life-Literature Review

Currently all ENERGY STAR-qualifying CFLs must have an average rated life of at least 6,000 hours, as declared by the manufacturer and demonstrated in the testing protocol required by the ENERGY STAR program. However, there has been concern that some products are not performing to the claimed standards. Consideration of measure life is important for a number of reasons. When energy-efficient lighting products are not as durable or do not perform as anticipated, program energy savings expectations are not met and consumer confidence in the products and the ENERGY STAR label is eroded, creating additional barriers to establishing sustainable markets for the products.

We investigated the existence of research on how adjustments can be made to the engineering life data provided by manufacturers, talking to Sponsors and other industry professionals and reviewing resources available on various industry websites. In California, several recent studies calculate measure retention rates (i.e., effective useful life) of lighting products, using measure retention data to create a parametric survival function for products over time. The effective useful life measure calculates the median survival time of products, which is the time at which half of the products distributed through a program and installed are no longer in place and operating. The model bases failure rates on the presence or absence of products at the time of the survey; therefore products may be considered failures merely by being removed, even if they have not failed physically[19]. As such, the model does not include an accounting of the physical limitations of products through measure life.

Elsewhere, there appears to be little work done to quantify measure life to account for failures to meet the engineering claims by manufacturers. The most comprehensive response to concerns about the quality and reliability of ENERGY STAR-qualifying lighting products comes from the Environmental Protection Agency (EPA) and several

[19] This methodology is used in several studies, including: *1996 and 1997 Residential Appliance Efficiency Incentives Program: Compact Fluorescent Lights, Sixth Year Retention Evaluation*. San Diego Gas & Electric. March 2003. Study ID No. 985. and
Retention Study of Pacific Gas & Electric Company's 1996 Residential Appliance Efficiency Incentives Program. Xenergy. April 2000. Study ID No. 372RI.

utilities that have been working with the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute to conduct standardized testing procedures and assess outcomes.

The Program for the Evaluation and Analysis of Residential Lighting (PEARL) at the LRC (for which Efficiency Vermont, National Grid, Northeast Utilities, and NSTAR, along with NEEP, are among the sponsors) serves as a testing program for efficient lighting products that are available to consumers; to date the program has conducted five cycles of testing. The PEARL testing has included measurements of efficacy, a 1000-hour lumen maintenance, color rendering index (CRI), correlated color temperature (CCT), lumen maintenance at 40% of rated life, power factor, run-up time, and rapid cycle stress test.

In viewing the PEARL testing results for measure life, a few notes about the testing procedure should be made. While no lifetime testing per se has been performed, the test of lumen maintenance at 40% of rated life provides the best proxy. In the PEARL test, the lumen output for CFL samples was measured at 1000 hours and then the samples were aged in the testing laboratory until each CFL sample reached its 40% of rated life using a 3-hour on/20-minute off cycle. The light or lumen output of the samples was then measured again. The lumen maintenance at 40% of rated life for each sample was then calculated as the ratio of the lumen output at 40% of rated life to the initial lumen output. Products were considered to meet the ENERGY STAR specification if the average of this ratio was equal to or higher than 80%.

Analysis of Measure Life

We could not use the PEARL results directly to refine any existing utility assumptions about measure life for products. PEARL testing has not been performed for the entire population of ENERGY STAR-qualifying products and is not necessarily even representative of the population of ENERGY STAR-qualifying products or the products offered by this study's Sponsors in their 2003 Residential Lighting Programs.

Due to the sensitive nature of the information being collected, PEARL testing results are confidential, and released only to its sponsors and manufacturers of targeted products. For purposes of this analysis, NMR was granted access only to descriptions of testing procedures and listings of the products tested; full testing results by product were not made available. Assumptions made about PEARL results as they relate to the mix of products available through the 2003 Residential Lighting Programs were made through cross-references to ENERGY STAR-qualifying product listings[20]; this listing became the primary means for identifying products that no longer carry the ENERGY STAR label.

The ENERGY STAR program maintains a list of over 1600 CFLs that have been qualified for the ENERGY STAR label. The listing includes an indicator for products that have since been disqualified from the program due to not meeting program requirements. It also identifies products that have been discontinued or retired by

[20] ENERGY STAR web site, CFL Product List (as of 5-21-04)
http://www.energystar.gov/ia/products/prod_lists/cfl_prod_list.xls

manufacturers, and so are no longer eligible to carry the ENERGY STAR label. Reasons for products being disqualified or discontinued/retired are not disclosed by the ENERGY STAR program, so it is not possible to determine the extent to which measure life factors into the loss of the ENERGY STAR label on products. Products can be disqualified for failing to meet any of the ENERGY STAR testing, performance, labeling, or packaging standards and manufacturers can voluntarily pull products from the ENERGY STAR qualifying list for any number of reasons (i.e., retiring or discontinuing a product line, etc.) that may not even be associated with product performance. In other words, we can not make an assumption about product measure life based on failure to meet ENERGY STAR standards.

In presenting the analysis, we note that significant barriers exist to identifying products sold through the 2003 RLP that are disqualified from ENERGY STAR listings. First, multiple databases at EFI are used to maintain program records; for this analysis we referenced five separate customer databases to obtain detailed product listings. The databases have similar, but not identical, means for identifying products sold through the program and catalog files often do not have manufacturer model numbers included in the product description, making any comparisons with ENERGY STAR listings difficult. A second barrier is matching manufacturer product model numbers from EFI and the ENERGY STAR product listings. Slight differences in the listings make accurate comparisons very difficult, even when both sources rely on manufacturer model numbers. For example, the EFI listing may rely on a manufacturer model number that identifies a product with a designation for the number of bulbs in the package, while the ENERGY STAR listing does not[21]. The result is that the two listings appear as different products, although they reference the same technology. The sheer number of products on the ENERGY STAR listing (over 1600) combined with hundreds of models sold through the 2003 RLP makes reconciliation of the differences by hand very difficult.

Our analysis focused on identifying CFLs sold through the 2003 RLP that have been disqualified or discontinued/retired from the ENERGY STAR program since January 1, 2003. Due to the large number of products available through the program, efforts were focused on checking the ENERGY STAR status of the CFL models most frequently sold through the 2003 RLP to get an estimate of the magnitude to which bulbs sold through the program may not perform as expected.

Based on this, it appears that at least 27,754 CFLs, representing 18 different product models and 17% of the CFLs sold through the 2003 RLP, have been disqualified from the ENERGY STAR listing. As Table 7-1 shows, the majority of the disqualified CFLs were sold through the Vermont program—34% of the CFLs sold in Vermont. Two of the disqualified CFL models sold in Vermont represent sales of 20,681 bulbs.

In addition, at least 1,694 CFLs sold through the 2003 RLP, representing 15 product models were discontinued or retired from the ENERGY STAR listing.

[21] Personal communication with Tim Brown at EFI (May 2004) confirmed that EFI tries to use model numbers supplied by manufacturers to identify products, but these model numbers can and do vary from the listings used by the ENERGY STAR program.

In interpreting these findings, it is important to remember that the reasons for products being disqualified or discontinued from the ENERGY STAR listings are unknown and we cannot make an assumption about product measure life based on them. However, they do provide an indication of the potential ceiling for the number of products that potentially have measure life problems.

Table 7-1: Number of CFLs Sold Through the 2003 RLP Taken Off ENERGY STAR List

	Disqualified	Discontinued/Retired
Total 2003 RLP	27,754	1,694
MA-RI RLP	4,588	1,435
Catalog	2,632	457
Coupon	1,956	978
VT RLP	23,166	259
Percent of CFLs sold through 2003 RLP	17%	1%

The ENERGY STAR program provides bulb life information for all CFLs that have received the ENERGY STAR label, as reported by manufacturers. As Table 7-2 shows, the average rated bulb life of the products sold through the 2003 RLP that were disqualified is 8,222 hours, while the average bulb life of all bulbs that were qualified for the ENERGY STAR label by December 31, 2003 was 7,703 hours.

Table 7-2: Average Rated Life of CFLs

	Average Hours
Disqualified	8,222
Discontinued	7,467
All ENERGY STAR bulbs eligible during 2003	7,703

Based on ENERGY STAR CFL product listing
(http://www.energystar.gov/ia/products/prod_lists/cfl_prod_list.xls)

It is also important to note that the ENERGY STAR program review of products is on-going and products can be disqualified or discontinued at any time of the year. This means that ENERGY STAR-qualifying products selected for inclusion in Sponsor programs in good faith may lose their ENERGY STAR status at a later point in time; this occurred with some products sold through the 2003 RLP. The loss of ENERGY STAR status is an on-going problem for Sponsors and retailers. While not necessarily applicable to the 2003 RLP, due to the long-lead times required for program planning, Sponsors and retailers potentially may be in a position of having product inventory that no longer qualifies for the ENERGY STAR label.

Due to the small number of ENERGY STAR-qualifying fixtures that have been PEARL tested, we did not review findings for this study; however, the LRC has completed research on fixture durability testing in August 2003 that established a methodology for helping to identify products that were likely to fail prematurely. This research focused on three areas that are likely to be involved in premature failures of residential lighting fixtures and identified testing procedures for each:

Heat testing: To determine if an elevated temperature inside a fixture also elevates the ballast case operating temperature, causing failure of electrolytic capacitors in electronic ballasts.

Rapid-cycle testing: To determine if the starting and operating electrical characteristics of the ballast damage lamps.

Voltage testing: To determine if supply voltage variation impacts ballast starting and operating electrical characteristics.[22]

The research concluded that heat may be a factor in premature failure of light fixtures; the ballast case operating temperatures inside some of the tested fixtures exceeded the maximum recommended temperature of 65º C to 75º C for performance, with "at least half of the ceiling mounted fixtures exceeded 75º C and more than 90% of the tested ceiling fixtures exceeded 65º C."[23] The report recommended that a temperature test be done for ENERGY STAR-qualifying fixtures.

The LRC research results were inconclusive about the rapid-cycle stress test, due to concerns about appropriate testing procedures and it determined that voltage variation "does not appear to be a primary cause of premature failure of ENERGY STAR fixtures."[24]

While no specific conclusions about the lifetime of fixtures sold through the 2003 RLP, these results suggest that for recessed and ceiling flush-mounted fixtures, there may be reason to believe that many of the products may fail prematurely.

[22] *Durability Testing for ENERGY STAR Residential Light Fixtures*, Final Project Report (Public Version), Sponsor, United States Environmental Protection Agency, by Lighting Research Center, Rensselaer Polytechnic Institute, Revised August 20, 2003.
[23] LRC, August 20, 2003.
[24] LRC, August 20, 2003.

8. Participant Awareness and Satisfaction

8.1. Prior Awareness of Energy-Efficient Lighting Products

The majority of program participants claim to have known about energy-efficient lighting products prior to the 2003 RLP. Seven out of ten (71%) respondents say they had at least a little knowledge of CFLs prior to the 2003 RLP, with 25% claiming above average or excellent knowledge. Slightly fewer (65%) had at least a little knowledge of CFL fixtures, with 16% claiming above average or excellent knowledge.

Catalog customers are significantly more likely than coupon customers to have had at least an above average knowledge of CFLs prior to the program; conversely, coupon customers are significantly more likely than catalog customers to have had no knowledge of CFLs. There are significant differences in prior knowledge of CFL fixtures between coupon and catalog customers across all knowledge levels, except those with excellent knowledge of the products. Again, catalog customers had greater prior knowledge of CFL fixtures than coupon customers. (Table 8-1)

Those familiar with CFLs have been aware of them for an average of six years; those familiar with CFL fixtures have been aware of them for an average of five years. (Table 8-2)

Table 8-1: Prior Knowledge of Energy-Efficient Lighting Products
(all survey respondents)

	CFLs			All Fixtures		
	Total	**Coupon**	**Catalog**	**Total**	**Coupon**	**Catalog**
n	823	515	308	823	515	308
Excellent Knowledge	9%	9%	9%	7%	7%	7%
Above Average Knowledge	16	14[b]	20	9	8[b]	14
Average Knowledge	29	28	33	27	25[b]	33
Little Knowledge	17	17	16	22	20[b]	30
No Knowledge	29	32[b]	22	31	37[b]	15
Don't Know	1	1	1	4	5	2

[a] Weighted to the population of each product. "Don't Know" responses and outliers from the number of additional products purchased removed.
[b]Significantly different from catalog at the 90% confidence level.

About three out of ten of those familiar with CFLs and CFL fixtures first learned about them through a utility company; slightly fewer learned about them through advertising or in the media, at a retailer, or through friends/family. There is little difference for CFLs and CFL fixtures in the type of education channels where respondents first learned about the products. (Table 8-2)

Table 8-2: How and When Respondents Found Out About Energy-Efficient Lighting Products

(all respondents with prior knowledge of products)[a]

	CFLs	All Fixtures
n[b]	684	617
Mean Number of Years Aware of the Products	6	5
How Found Out (n)	687	636
Through the utility (not specifically named)	25%	24%
Advertisement	28	24
Friend or Family	12	11
Retailer or Store	17	21
Specific Utility	5	5
Mass Electric	2	2
Narragansett	1	1
WMECO	<1	<1
NSTAR	1	2
Cape Light	0	<1
Media	3	3
Demonstration/Program	1	1
Through work	3	1
Received in mail	<1	0
Catalog	1	1
School	0	<1
Don't Know	7	10

[a] Weighted to the population of program participants.
[b] Outlier and impossible answers (e.g., knowledge longer than products have been on market) removed. "Don't know" responses moved from mean number of years.

8.2. Prior Use of Products

While the majority of participants were familiar with energy-efficient lighting products prior to their participation in the 2003 RLP, only 45% had bought or received any CFLs and only 27% had bought or received any CFL fixtures prior to the program. The majority of participants either purchased or received the CFLs or CFL fixtures through a utility or energy efficiency program; this finding underscores the importance of utility support in bringing these products to homes. (Table 8-3 and Table 8-4) Prior experience with CFLs is higher in MA and RI, where there is a longer history of utility sponsored programs, than in VT (46% and 38% respectively, had bought or received CFLs prior to the program).

Table 8-3: Had Purchased or Received Energy-Efficient Lighting Products Prior to Participation in the RLP

(all respondents with prior knowledge of products)[a]

	CFLs	All Fixtures
n	687	636
Yes	45%	27%
No	52	72
Don't Know	3	2

[a] Weighted to the population of program participants.

Table 8-4: Prior Purchase/Receipt Made through a Utility or Energy-Efficiency Program

(all respondents with prior product purchases)[a]

	CFLs	All Fixtures
n	305	172
Yes	62%	50%
No	36	49
Don't Know	2	1

[a] Weighted to the population of program participants.

Respondents were asked to identify, by room, how many additional CFLs they had installed in their homes, in addition to the products purchased through the 2003 RLP. The majority of respondents had been using CFLs in the living room, kitchen, bedroom, and outside the home—areas of the home that typically have higher lighting use. (Table 8-5)

Finally, 687 respondents who had purchased CFLs prior to participating in the RLP report that, on average, they have a total of nine CFLs in use in the house (including prior and post-program purchases). If we weight their responses to the population, there are approximately 251,318 CFLs installed in the homes of participants (with about 141,000 purchased directly through the RLP.

Table 8-5: Number of Additional CFLs Installed by Room (Non-RLP Purchases)
(all respondents installing CFLs)

	n	Number	Percent of Households
Living Room	247	26,156	39%
Kitchen	107	9,791	38
Dining Room	26	1,070	13
Hall/Foyer	72	4,137	13
Bedroom	96	6,438	26
Bathroom	37	1,446	16
Garage	11	75	7
Exterior/Outside	38	2,068	31
Closet	4	0[b]	0
Utility Room	11	0[b]	0
Basement	40	5,547	36
Office	4	0[b]	0

[a] Weighted to the population of CFLs purchased.
[b] Weighting procedure reduces impact to zero.

8.3. Satisfaction with Products

The vast majority of respondents are satisfied with the products they purchased through the 2003 RLP, with satisfaction levels ranging from 89% (torchieres) to 94% (CFLs). (Table 8-6)

Table 8-6: Satisfaction with Energy-Efficient Lighting Products Purchased through the RLP
(all respondents who installed products in their home, even if products were removed)[a]

	CFLs	Torchieres	Interior Fixtures	Exterior Fixtures
n	394	182	310	150
Very Satisfied	72%	69%	58%	62%
Satisfied	22	20	34	29
Neither Satisfied or Dissatisfied	2	4	3	5
Dissatisfied	1	4	3	<1
Very Dissatisfied	1	3	1	3
Don't Know	2	0	1	3

[a] Weighted to the population of program participants.

Very few respondents noted dissatisfaction with any of the products purchased. Those dissatisfied with the CFLs and interior fixtures primarily cited reasons associated with poor light quality/not enough light and premature product failure. Dissatisfaction with torchieres primarily focused on defective/poor fixture quality. Dissatisfaction with exterior fixtures was not concentrated on a single factor, but included reasons associated with poor light quality, premature failure, and defective/poor fixture quality. (Table 8-7)

Table 8-7: Reasons for Dissatisfaction with Energy-Efficient Lighting Products Purchased through the RLP

(all respondents who indicated dissatisfaction, multiple response, n's reported)[a]

	CFLs	Torchieres	Interior Fixtures	Exterior Fixtures
n	12	12	12	5
Not enough light/poor light quality	4	2	6	2
Premature failure	4	1	5	2
Defective or poor fixture quality, won't work when below freezing	0	5		2
Flicker	1	0	1	0
Slow warm-up	0	0	1	0
Burning smell	1	0	0	0
Too bright	1	0	0	0
Expensive	1	0	0	0
Light not effective	1	0	0	0
Poor fit	2	0	0	0
Interferes with electronics	0	1	0	0
Don't know	0	4	0	0

[a] Not weighted due to small n's.

9. Comparison of Telephone Survey Results to On-Site Survey

The telephone survey methodology of program evaluation relies on respondent self-reporting. This methodology is appropriate for assessing respondent motivation, attitudes, and opinions; in this evaluation, we also use it to assess participant behavior (i.e., hours of usage) and for technical accounting (i.e., product counts, wattage, etc.). To fully address these behavioral and technical accounting aspects of lighting usage, this evaluation also included on-site surveys of participants; those findings form the basis for the savings estimates that are used by the Sponsors. However, the question that should be asked is how well does the telephone survey methodology account for respondent actions—not just their intentions.

This section compares selected parameters from the telephone survey to corresponding measures collected in the on-sites. The results help to identify if there are differences in self-reported and actual behavior and the directionality of the differences. We also examine ways to leverage the relationship between the on-site and telephone survey data to take advantage of the larger sample size of the latter and the greater accuracy of the former.

9.1. Limitations to Comparison of On-Site to Self-Reported Installation and use rates

Comparing the installation and use rates obtained from the on-site studies and telephone surveys presented difficulties revolving around inconsistencies between what was actually logged and respondent recall of product installation and use in the telephone survey. The inconsistencies have two sources. First, due to the limited number of loggers and the scope of the study, not every product purchased through the 2003 RLP was logged in the homes that were visited. For example, one customer purchased five CFLs through the RLP, installing two of them; we only logged one CFL in his home. Second, respondents in the telephone survey had a difficult time recalling exactly how many products they purchased and the exact location of where those products are installed. For example, according to EFI's records, a particular customer had purchased one CFL through the RLP. However, when asked, this customer told us that he had purchased 10 through the RLP.[25]

[25] The confusion of this respondent is understandable. The on-site inspection found that this individual had 91 CFLs installed in his home.

These two sources of error created three inconsistencies in reporting.[26] First, we found that customers often failed to report that they had products installed in the rooms in which products were logged. Less commonly, they reported installing more products in the same rooms in which we logged. The source of respondent error is unknown; it may be due to the fact that the customer could not identify 2003 RLP purchases from other recent lighting purchases, forgot where the product purchased through the RLP was installed, or installed the product after the telephone survey was conducted, or—in the interest of moving the survey along—might have given the first answer that came to their head instead of taking the time to think about the answer more thoroughly.

A third situation occurred that is also problematic in comparing results. Specifically, products logged were not always located in the rooms in which customers reported having them installed in the telephone survey. Thus, a customer may have said they installed products in their hall, but we did not log any products in the hall. This third situation could indicate that the customer incorrectly identified the room where the product was installed or the product purchased through the 2003 RLP. Alternatively, despite efforts to match product manufacturer and model numbers from the EFI database of customer purchases to products logged, this information was not universally available; it may be that non-program purchases were logged.

These inconsistencies of course, are among the reasons we need conversion factors. Therefore, we have not adjusted any of the logged or self-reported data to address these inconsistencies. In other words, if a respondent told us they had purchased ten CFLs and installed all ten of them, we took the respondent at his or her word even if the EFI and logged data suggest otherwise; after all, to answer questions about lighting products requires customers to agree that they actually have acquired those products. However, because we did not attempt to adjust for these inconsistencies before analyzing the data, the sample sizes (n's) as measured as number of households/respondents, number of products purchased, or number of products installed (depending on the analysis) are often quite different.

In addition to comparing on-site results with the telephone survey results of those who received on-site visits, we also compare both sets of results to the overall telephone survey results. The former comparison benefits from verification of telephone survey findings, but suffers from small sample sizes. The latter comparison involves no direct verification, but has much larger sample sizes. Triangulation among the three samples forms the basis of our recommended "correction factors" for other telephone surveys to be conducted in the future.

[26] While we have not presented room-by-room results in this report (the sample sizes were too small, all falling at or below 14—most below 5—for each room and product assessed), the fact that data were collected by room in both the on-site study and the telephone survey means that all of our comparison data from the two sources had to start with a room-by-room comparison. We then summed or averaged data, depending on the purpose of the analysis, across rooms to arrive at the results. Also note that exterior fixtures were not subject to room-by-room breakdowns, but we have followed the same procedures for this product for consistency.

9.2. On-site vs. Self-Reported CFL Counts

Table 9-1 compares the self-reported household CFL count (that is, all CFLs—not just those acquired through the coupon and catalog portions of the 2003 RLP) of all respondents to those who participated in the on-site logging study and those who did not. The results show that the respondents from homes in which we logged reported having more CFLs installed than did those from which we did not log. There may be some self-selection bias among those who agreed to on-site visits; it may be that they are more enthusiastic users of CFLs, and they are also younger and better educated. In addition, the logged results are observed results for a small number of people, but do not offer acceptable precision levels due to the limited sample size. Once the logged numbers are extrapolated to the larger survey population, we arrive at a number that incorporates actual observations with better precision.

The proper "correction factor" to use for other telephone surveys is the ratio of on-site counts (14.4 per household) to the self reports among the on-site sample (9.2 per household). The suggested ratio would result in a "correction factor" of 1.6. Applied to the 8.0 CFLs per household as self-reported by all telephone survey respondents, this would suggest that catalog and retail RLP participants have an average of 12.5 (or 8.0 times 1.6) CFLs installed per household. This correction factor, of course, is subject to verification in other studies. Moreover, even if correct, this correction factor could be unique to Massachusetts, Rhode Island, and Vermont at this particular time, given the uniqueness of the area and the current state of the lighting market. This correction factor should probably not be used—even in Massachusetts, Rhode Island, and Vermont—for more than a couple of years.

Table 9-1: CFL Total Count: Self-Reported and Counted During On-Site
(all data weighted to total CFL population and channel of purchase except the RLW count, which is unweighted)

	Overall	Retail	Catalog
Telephone Survey: All Respondents			
n	689	423	266
Mean	8.0	8.0	7.8
No On-Site Study			
n	586	369	217
Mean	7.8	8.0	7.3
On-Site Study, Self-Reported			
n	103	54	49
Mean	9.2	8.5	10.0
On-Site Study Counted by RLW			
n	115	63	52
Mean	14.4	13.1	16.0
Correction Factor [a]	1.57	1.54	1.60
Revised Telephone Survey Estimate	12.6	12.3	12.5

[a] Ratio of counted to on-site self-reported

9.3. On-Site vs. Self-Reported Installed RLP Product Counts

Table 9-2 details the average number of products purchased through the 2003 RLP that were either counted as installed from the on-site visit or self-reported as installed during the telephone surveys, with additional breakdowns by purchase channel. Respondent self-reports tend to be higher than logged counts for CFLs, lower for torchieres, and about the same for interior and exterior fixtures. The overestimates of RLP CFLs may result from respondents' inability to recall which CFLs they purchased through catalog and retail coupon channels and those they purchased through other channels, and an inability to distinguish between those purchased in 2003 and those purchased before or since.

Table 9-2: Average Number of Installed RLP Products Counted and Self-Reported by Coupon and Catalog Sales

(number of households)

	Overall		Coupon		Catalog	
	n	**Ave.**	**n**	**Ave.**	**n**	**Ave.**
CFLs						
Counted by RLW	59	2.8	17	3.4	42	2.6
On-Site Sample Self-Reported[a]	58	4.1	16	4.4	42	3.7
Telephone Sample Self- Reported[a]	407	3.7	204	4.0	203	3.0
Correction Factor[b]		0.68		0.77		0.70
Revised Telephone Survey Estimate		2.5		3.1		2.1
Torchieres						
Counted by RLW	34	1.4	12	1.5	22	1.3
On-Site Sample Self-Reported[a]	33	1.0	12	1.0	21	1.0
Telephone Sample Self- Reported[a]	194	1.4	104	1.4	90	1.3
Correction Factor[b]		1.40		1.50		1.30
Revised Telephone Survey Estimate		2.0		2.1		1.7
Interior Fixtures						
Counted by RLW	43	2.0	23	1.9	20	2.3
On-Site Sample Self-Reported[a]	47	2.0	28	2.0	19	1.8
Telephone Sample Self- Reported[a]	328	1.6	206	1.7	122	1.4
Correction Factor[b]		1.00		0.95		1.28
Revised Telephone Survey Estimate		1.6		1.6		1.8
Exterior Fixtures						
Counted by RLW	44	1.8	24	1.6	20	2.1
On-Site Sample Self-Reported[a]	46	1.6	25	1.6	21	1.7
Telephone Sample Self- Reported[a]	172	1.3	86	1.4	86	1.2
Correction Factor[b]		1.13		1.00		1.24
Revised Telephone Survey Estimate		1.5		1.4		1.5

[a] Don't know responses removed from the sample size and results

[b] Number logged divided by on-site sample self-reported

9.4. On-Site vs. Self-Reported RLP Product Installation Rates

Table 9-3 shows self-reported and counted/verified installation rates. Compared to self-reports, verified counts are lower for nearly all product types and channels. Self-reports for CFLs and exterior fixtures are closer to verified counts among coupon purchasers than among catalog purchasers. The revised phone survey estimate of lighting installation rates are also shown in this table. The precision estimates provided were calculated at the 90% confidence level based on the phone survey results following application of the correction factor.

Table 9-3: Installation Rates—Self-Reported and Counted During On-Site
(number of products)

	Overall		Coupon		Catalog	
	n	**Ave.**	**n**	**Ave.**	**n**	**Ave.**
CFLs						
Counted by RLW	302	62%	84	76%	218	59%
On-Site Sample Self-Reported	259	84%	77	82%	182	85%
Telephone Sample Self- Reported	1,659	82%	940	80%	719	84%
Correction Factor [a]		0.74		0.93		0.69
Revised Telephone Survey Estimate Precision		61% ±2.0%		74%		58%
Torchieres						
Counted by RLW	58	81%	18	88%	40	82%
On-Site Sample Self-Reported	56	92%	21	90%	35	94%
Telephone Sample Self- Reported	307	86%	163	86%	144	85%
Correction Factor [a]		0.88		0.91		0.94
Revised Telephone Survey Estimate Precision		76% ±4.0%		78%		80%
Interior Fixtures						
Counted by RLW	115	76%	59	73%	56	82%
On-Site Sample Self-Reported	100	91%	62	91%	38	95%
Telephone Sample Self- Reported	595	86%	394	85%	1201	88%
Correction Factor [a]		0.84		0.80		0.86
Revised Telephone Survey Estimate Precision		72% ±3.0%		68%		76%
Exterior Fixtures						
Counted by RLW	104	80%	43	91%	61	72%
On-Site Sample Self-Reported	87	89%	46	90%	41	88%
Telephone Sample Self- Reported	287	80%	138	85%	149	69%
Correction Factor [a]		0.90		1.01		0.82
Revised Telephone Survey Estimate Precision		72% ±4.3%		86%		56%

[a] Ratio of counted to on-site self-reported hours

9.5. On-Site vs. Self-Reported Installations by Room Locations

We also explored whether the location of logger installations was different than room locations identified by non-logger respondents in the phone survey. Table 9-4 through Table 9-6 show the percentage of units installed, with breakdowns by observed installations of logger respondents and respondents not logged. The tables show a significantly greater percentage of installations of all product types in the living room—a high lighting-use area—by survey respondents compared to logged results. In addition, a significantly smaller percentage of CFLs were installed outdoors and in the basement by survey respondents compared to the logger study. For torchieres, other significant differences in installation and logged products exist in the utility room, office, and TV room/den. For interior fixtures, other significant differences were found in the hall, bathroom, garage, closet, basement, and office.

However, the differences between logged and self-reported results are already taken into account in the adjustments to logged results made in the July 29 version of the report; the key differences we are looking for here are between the self reports of logger respondents and those not logged. Table 9-4 shows that for CFLs, self-reported use by logger respondents compared to non-logger respondents is significantly higher in the living room and hall (high-use areas) and significantly lower in the kitchen (high-use area), bedroom, bath and utility room (medium-lower-use areas). Table 9-5 shows that for torchieres, with the exception of the utility and office/study, there are no significant differences between self-reported use by logger and non-logger respondents. Table 9-6 shows that for interior fixtures, self-reported use by logger respondents compared to non-logger respondents is significantly higher in the hall (high-use area) and bathroom (medium-lower-use area) and significantly lower in the living room, kitchen (high-use areas), garage, and office (medium-lower-use areas).

Table 9-4: Comparison of CFLs Installed and Logged

	Survey, Respondent Self-report			Logger Survey
	Not in Logger	In Logger	Total	Logged
n	1143	225	1368	98
Living	36%	44%[a]	37%	17%[a]
Kitchen	16%	12%[a]	16%	13%
Dining	4%	5%	4%	2%
Hall	9%	16%[a]	10%	14%
Bedroom	15%	8%[a]	14%	19%
Bath	5%	2%[a]	5%	4%
Garage	1%	1%	1%	2%
Exterior	4%	6%	4%	11%[a]
Closet	0%	0%	0%	1%
Utility	1%	0%[a]	1%	0%[a]
Basement	7%	5%	7%	13%[a]
Other	1%	1%	1%	2%

[a]Significantly different from households not logged in survey at the 90% confidence level.

Table 9-5: Comparison of Torchieres Installed and Logged

	Survey, Respondent Self-report			Logger Survey
	Not in logger	In logger	Total	Logged
n	226	51	277	44
Living	55%	59%	55%	36%a
Kitchen	2%	2%	2%	2%
Dining	5%	4%	4%	9%
Hall	1%	0%	1%	0%
Bedroom	27%	30%	28%	27%
Bathroom	0%	0%	0%	0%
Garage	1%	0%	1%	0%
Closet	1%	0%	1%	0%
Utility	2%	0%a	2%	0%a
Basement	4%	6%	5%	7%
Office/Study	3%	0%a	2%	16%a
TV room/Den	0%	0%	0%	9%a

[a]Significantly different from households not logged in survey at the 90% confidence level.

Table 9-6: Comparison of Interiors Installed and Logged

	Survey, Respondent Self-report			Logger Survey
	Not in logger	In logger	Total	Logged
n	490	92	512	71
Living	39%	27%a	37%	23%a
Kitchen	19%	11%a	18%	14%
Dining	3%	3%	3%	4%
Hall	10%	20%a	12%	20%a
Bedroom	16%	22%	17%	15%
Bathroom	3%	14%a	5%	11%a
Garage	2%	0%a	2%	0%a
Closet	2%	2%	2%	0%a
Utility	2%	1%	2%	3%
Basement	3%	2%	3%	0%
Office	1%	0%a	1%	6%a
Other	0%	0%	0%	4%a

[a]Significantly different from households not logged in survey at the 90% confidence level.

9.6. On-Site vs. Self-Reported Hours of Use

The results in this section compare the daily number of hours RLP products were actually used throughout the home, as measured by loggers, to the *summer* hours that individuals reported using the products. Although we asked respondents about summer and winter use, the loggers were placed in homes during the late spring, one of the brightest times of the year. Therefore, summer use is a more appropriate comparison than winter use. In addition, as mentioned above, the sample size and data characteristics did not allow us to limit the comparison of use to those products correctly identified by customers as being in the rooms in which logging occurred.

As Table 9-7 shows, the average daily self-reported use of CFLs is higher than logged use, even after removing outliers[27]. This suggests that telephone respondents over-report the number of hours they use CFLs.[28] Respondents also tend to over-report hours of use for interior fixtures, but not for torchieres or exterior fixtures. The revised phone survey estimate of daily operating hours is also shown in this table. The precision estimates provided were calculated at the 90% confidence interval based upon the phone survey results following application of the correction factor.

Table 9-7: Overall Daily Hours Products Used: Loggers and Self-Reported Estimates

(number of products)

	Overall		Coupon		Catalog	
	n	**Ave.**	**n**	**Ave.**	**n**	**Ave.**
CFLs						
Logged	97	2.6	44	2.6	53	2.7
On-Site Sample Self-Reported	219	3.2	64	2.8	155	3.7
Telephone Sample Self-Reported	1,358	4.2	756	4.3	602	3.7
Correction Factor [a]		0.81		0.93		0.73
Revised Telephone Survey Estimate Precision		3.4 ±7.8%		4.0		2.7
Torchieres						
Logged	44	2.5	13	2.0	31	2.7
On-Site Sample Self-Reported	52	2.4	19	2.1	33	2.8
Telephone Sample Self-Reported	263	2.9	141	2.8	263	3.3
Correction Factor [a]		1.04		0.95		0.96
Revised Telephone Survey Estimate Precision		3.0 ±11.5%		2.7		3.2
Interior Fixtures						
Logged	71	2.1	43	2.1	28	2.1
On-Site Sample Self-Reported	92	2.5	56	2.5	36	2.5
Telephone Sample Self-Reported	512	3.1	337	3.1	175	3.2
Correction Factor [a]		0.84		0.84		0.84
Revised Telephone Survey Estimate Precision		2.6 ±9.1%		2.6		2.7
Exterior Fixtures						
Logged	78	4.0	35	4.2	43	3.9
On-Site Sample Self-Reported	77	4.3	41	4.2	36	4.7
Telephone Sample Self-Reported	225	4.8	117	4.8	108	4.8
Correction Factor [a]		0.93		1.00		0.83
Revised Telephone Survey Estimate Precision		4.5 ±14.1%		4.8		4.0

[a] Ratio of logged to on-site self-reported hours

[27] Outliers were always initially identified by the inter-quartile range method. After identifying potential outliers, we examined each more carefully and used professional judgment to determine whether or not to remove the outlier.

[28] It is also possible that the early spring timing of the telephone survey affected summer use estimates. People may not have accurately accounted for how they would use lights in May and June, when the logging typically occurred. Perhaps the long-term lighting study will provide clarification, as it will include time periods with shorter days.

In an effort to provide greater specificity in the comparison, we also summarized average daily use by high and low lighting use rooms[29] and by coupon catalog sales channels. For CFLs, but not for torchieres or fixtures, respondents' self-reported hours of use are closer to logged hours for high-use rooms than for low-use rooms. (Table 9-8)

Table 9-8: Overall Logged and Self-Reported Daily Hours by High- and Low-Use Rooms

(number of respondents)

	Logged During On-Sites		Self-Reported by Participants in On-Sites		Self Reported in Telephone Survey	
Room Lighting Use	**High**	**Low**	**High**	**Low**	**High**	**Low**
CFLs						
n	26	21	44	17	357	158
Average Use Per Unit	3.0	2.1	3.1	2.6	4.3	3.3
Torchieres						
n	19	17	22	12	139	61
Average Use Per Unit	2.7	2.3	2.6	2.3	3.0	2.6
Interior						
n	31	11	36	13	234	84
Average Use Per Unit	1.9	1.8	2.3	2.3	3.7	2.6

"Don't know" responses removed from the total.

9.7. Program Savings Using Adjusted Input Parameters

We recommend the Sponsors consider using an adjustment factor to guide assumptions that will be used for 2005 planning. For illustration purposes, Table 9-9 presents the annual savings as calculated from the phone-adjusted on-site installation rate and hours of use input parameters. Calculated in this manner, the overall savings are estimated to be 9,155 MWh for all lighting types. Similar to earlier tables, this table also provides realization rates as calculated against per unit savings calculated from utility provided input parameters. The overall realization rate is calculated to be 63.4%.

[29] Using definitions described in the ENERGY STAR Advanced Lighting Package Program specifications.

Table 9-9: 2003 Annual Energy Savings at Time of On-site Based Upon Adjusted Installation and Hours of Use Estimates

Sponsor	CFL Bulbs	Interior Fixtures	Exterior Fixtures	Torchieres	All Lighting Types
Number of Products Purchased					
National Grid	52,863	15,085	2,827	3,849	74,624
NSTAR	32,186	9,836	956	2,634	45,612
Unitil	600	105	8	79	792
WMECo	10,087	2,754	793	1,304	14,938
Cape Light	4,658	1,725	228	572	7,183
Vermont	67,394	8,702	1,270	2,116	79,482
Total	167,788	38,207	6,082	10,554	222,631
KWh Energy Savings					
National Grid	1,948,868	501,964	316,602	370,923	3,138,358
NSTAR	1,186,582	327,300	107,065	253,835	1,874,782
Unitil	22,120	3,494	896	7,613	34,123
WMECo	371,871	91,641	88,810	125,665	677,987
Cape Light	171,724	57,401	25,534	55,123	309,781
Vermont	2,484,573	289,565	142,230	203,916	3,120,285
Total	6,185,737	1,271,366	681,137	1,017,076	9,155,316
Realization Rate					
National Grid	65.0%	56.0%	175.3%	33.0%	60.4%
NSTAR	101.0%	78.5%	239.1%	34.0%	78.7%
Unitil	54.2%	35.6%	119.7%	29.2%	44.1%
WMECo	93.9%	36.9%	124.1%	65.6%	74.7%
Cape Light	98.7%	79.6%	133.4%	33.8%	72.3%
Vermont	60.5%	41.9%	140.9%	37.4%	57.3%
Total	69.5%	54.4%	163.0%	36.4%	63.4%

10. Comparison to Other Studies

This section of the evaluation provides a review of selected findings from other lighting studies conducted by the Sponsors. These studies were reviewed by the evaluation team in the creation of survey instruments; selected findings from the studies are discussed here in relation to the findings from this evaluation.

The following studies were used in this comparison. We have also provided a brief description of the methodology used in each study as appropriate.

- *1998 Process and Impact Evaluation of Joint Utilities Starlights Residential Lighting Program*. This study consisted of the performance of 753 telephone surveys.
- *2000 Xenergy Torchiere Study*. The results from this study are based on a participant telephone survey; hours of operation based on survey data and long-term metering data from a previous study.
- *2000-2001 Northeast Utilities SLC and POP Impact Evaluation*, April, 2003. This study consisted of a nested sample data collection structure with 613 phone surveys and 153 on-sites.
- *2002 NSTAR Residential High Use Program Operating Hours Realization Study*. This study utilized 59 on-sites and 330 lighting loggers to calculate a residential hours of use realization rate. This study does not provide results by lighting type and this study does not provide wattage reduction estimates.
- *The 2002-03 Process and Impact Evaluation of the New Hampshire RLP* included both a telephone survey of participants and an on-site logger study; results presented here are based on the on-site logger study.

Table 10-1 compares the installation rates calculated from the current study to similar studies performed in the region in the last several years. The current study made a distinction between interior and exterior fixtures; however most other studies do not provide results at this level. Two notable inconsistencies in the installation rates of this study and other studies are that of the Starlights study bulb results and the NH study fixture results. The difference between this study and Starlights may be due to the increased saturation of CFLs in 2004 as opposed to 1998 which may be causing an increased stocking behavior observed in the on-sites for this study as opposed to the Starlights study. The lower fixture installation rate in the NH RLP study was described as due primarily to "three customers in the sample that purchased fixtures but never installed them, perhaps due to the need for an electrician or a lack of time to install the fixtures themselves."

Table 10-1: Installation Rate Value Comparison

Study	In Store Lamps	Catalog Lamps	In Store Fixtures	Catalog Fixtures	In Store Torchieres	Catalog Torchieres
Current Study On-Site Install Rates *90% Confidence Interval*	61.6% *±7.5%*	61.6% *±7.5%*	Int: 76.5% *±10.1%* Ext: 79.8% *±9.9%*	Int: 76.5% *±10.1%* Ext: 79.8% *±9.9%*	81.0% *±13.1%*	81.0% *±13.1%*
1998 Starlights Study	73.1%	81.4%	60.6%	90.0%		
2000 Torchiere Study					86.3%	86.3%
2000-01 NU SLC/RL Study	70%	65%	80%	77%	74.3%	87.6%
2002 NSTAR RHU HOO Study	82%					
2002-2003 NH RLP Study	62.3%	62.3%	53.2%	53.2%	87.5%	87.5%

Table 10-2 presents a comparison of the wattage reduction rates calculated from the current study with rates calculated in similar studies performed in the region in the last several years. Generally, the findings from this study fall within the range of findings from other studies with respect to estimated wattage reduction. Bulb wattage reductions in the current study are somewhat lower than in the Starlights and NU study, perhaps due to the increased prevalence of program bulbs replacing previously purchased efficient bulbs. The largest difference in wattage reduction between this and other studies is in torchieres. This appears to be due primarily to a decrease in halogen torchieres as the pre-existing condition of program purchases. Indeed, in the torchieres study conducted by Xenergy. Thirty-six percent of catalog torchiere purchases and 64% of in-store torchiere purchases were reported to have replaced halogen torchieres. In the current study, approximately 26% of the torchieres observed on-site were found to replace higher-wattage halogen torchieres, while the remaining torchieres were replacing incandescent portables, which have much lower pre-purchase wattages associated with them.

Table 10-2: Wattage Reduction Rate Value Comparison

Study	In Store Lamps	Catalog Lamps	In Store Fixtures	Catalog Fixtures	In Store Torchieres	Catalog Torchieres
Current Study On-Site Wattage Reduction Rates *90% Confidence Interval*	48.7 *±5.0%*	48.7 *±5.0%*	Int: 48.7 *±10.0* Ext: 94.7 *±11.4*	Int: 48.7 *±10.0* Ext: 94.7 *±11.4*	115.8 *±15.5%*	115.8 *±15.5%*
1998 Starlights Study	54.8	54.8	75.4	71.5		
2000 Torchiere Study					261.0	261.0
2000-01 NU SLC/RL Study	52.0	47.0	104.0	65.0	193.0	118.0
2002-2003 NH RLP Study	40.9	40.9	85.3	85.3	169.9	169.9

Table 10-3 compares the hours of use calculated from this study with figures from previous studies. Generally, the daily hours of use estimate from this study is consistent with the NSTAR RHU program, but is lower than the other studies. This may be the result of purchasers installing lighting in areas of with lower lighting use hours due to previous efficient lighting purchases in locations with higher hours of use. Although adjustments were made to normalize the seasonal effect of the logging period (May and June) in the annual hours of use expansion, extended metering being performed at this time will provide longitudinal data to true up this estimate. It is also important to note that the average hours of use for interior and exterior fixtures in this study are close to the overall fixture average found in previous studies.

Table 10-3: Daily Hours of Use Rate Value Comparison

Study	In-Store Lamps	Catalog Lamps	In-Store Fixtures	Catalog Fixtures	In-Store Torchieres	Catalog Torchieres
Current Study On-Site Daily Hours *90% Confidence Interval*	2.7 *±17.7%*	2.7 *±17.7%*	Int: 2.1 *±24.3%* Ext: 4.0 *±17.7%*	Int: 2.1 *±24.3%* Ext: 4.0 *±17.7%*	2.5 *±10.4%*	2.5 *±10.4%*
1998 Starlights Study	3.4	3.44	3.4	3.44		
2000 Torchiere Study					3.46	3.46
2000-01 NU SLC/RL Study	3.4	4.5	3.0	3.0	3.4	3.4
2002 NSTAR RHU Program	2.39					
2002-2003 NH RLP Study	4.7	4.7	3.2	3.2	3.7	3.7

11. Demographics

As Table 11-1 and Table 11-2 show, people buying efficient lighting products through the 2003 RLP are significantly different from the general population on most demographic characteristics. Respondents are more likely than the general population to have graduate degrees, to live in single-family homes, to own rather than rent, to be in the 35 to 54 age group, and to have lower middle or high incomes rather than low or higher-middle incomes. In addition, respondents tend to be men rather than women, indicating that more men are making purchases of energy efficient lighting products, or at least having their names put on coupons and catalog orders. (In conducting the survey, we asked to speak to a specific individual—the name on the coupon or order form.)

Table 11-1 and Table 11-2 also provide breakdowns by respondents who participated in the on-site logging survey and those who did not. Logger respondents share many of the general characteristics of respondents not logged when compared to the general population: well educated, have children in the home, higher income, own their home, live in single-family home, male. However, compared to respondents not logged, logger respondents are significantly different on the following demographic characteristics:

Age: Under 35 years (15% logger respondents v. 8% not logged)
35 to 54 years (46% v. 56%)
Educational equivalent of high school or less (11% v. 19%)
Household size of one (21% v. 9%) or two people (31% v. 39%)
Household members under 18 (54% v. 43%)
Number under 18=1 (28% v. 20%)
Number under 18=2 (19% v. 11%)
Income $50,000 to $74,999 (22% v. 30%)
Income $75,000 to $99,000 (24% v. 14%)
Own home (95% v. 91%)
Multifamily dwelling (20% v. 13%)

In this analysis, we also noted a tendency for respondents not logged to have higher refusal rates on many questions compared to those who participated in the logger study. For illustration purposes, we add these data in Table 11-1. Questions about age, education, household size, number of household members home during weekdays, and income related yield significant differences on refusal rates between logger respondents and respondents not logged. Higher refusal rates for demographic questions among those not logged is consistent with a slightly older population and a lack of willingness to participate in the logger study.

Table 11-1: Demographic Characteristics of Survey Respondents

	Survey Respondents	Massachusetts Residents / Households[a]	Logger		No Logger	
n	**823**	**6,349,097-population 2,443,580-households**	**120**		**703**	
			Not Including Refusal Responses	**Including Refusal Responses**	**Not Including Refusal Responses**	**Including Refusal Responses**
Age of Householder/Respondent						
up to 34 years	9%c	21%	15%c,e	15%c,e	8%c	7%c
35-54	55c	43	46e	45	56c	50c
55 or over	36	35	39	38	36	33
Refused				2e		10
Education						
up to High School Grad,	19%c	42	11%c,e	11%c,e	19%c	18%c
Some or College Grad.	36c	44	37	37	36c	33c
Graduate degree	46c	14	52c	52c,e	45c	42c
Refused				1e		8
Gender						
Male	66%c	47%		66%c		65%c
Female	35c	53		34c		35c
Household Size						
1	10%c	28%	21%c,e	21%c,e	10%	9%c
2	38c	32	31e	31e	43	39c
3	17	16	19	19	18	16
4	14	14	15	15	15	14
5 or more	14c	9	14	14	15	14c
Refused	8			2e		9c
Household with Members Under 18	44%c	33%	56%e	54%c,e	44%	43%c
Number of Members Under 18 [b]						
0	55%	NA	44%e	42%e	56%	56%
1	20	NA	29e	28e	20	20
2	12	NA	20e	19e	11	11
3	7	NA	5	5	7	7
4	4	NA	1e	1e	5	5
5 or more	<1	NA	1	1	<1	<1
Refused	2	NA		4		2

Table 11-1: Demographic Characteristics of Survey Respondents

	Survey Respondents	Massachusetts Residents / Households[a]	Logger		No Logger	
n	**823**	**6,349,097-population 2,443,580-households**	**120**		**703**	
			Not Including Refusal Responses	**Including Refusal Responses**	**Not Including Refusal Responses**	**Including Refusal Responses**
Household Members Home During Weekdays						
0	25%	NA	32%	31%	28%	25%
1	36	NA	43	42	39	35
2	20	NA	16e	16	23	21
3	5	NA	6	6	6	5
4 or more	3	NA	2	2	4	3
Outlier or Refused	11	NA		3e		11
Household Income						
Less than $35,000	12%c,d	35%	9%c	5%c	12%c	5%c
$35,000-$49,999	17d	15	20	10c	16	7c
$50,000-$74,999	29c,d	20	22e	11c	30c	12c
$75,000-$99,000	15d	13	24c,e	12e	14	5c
$100,000 or more	28c,d	18	25c	12c	28c	11c
Refused				51e		61

[a]Data from the 2000 Census. When available and comparable; base differs by measure due to Census data collection methods and comparability with the potential survey sample.
[b]Based on 669 respondents with more than one person living in the home.
[c]Significantly different from MA general population at the 90% confidence level.
[d]Percentage based on those responding; refused responses excluded.
[e]Significantly different from households not logged in survey at the 90% confidence level.

Table 11-2: Housing Characteristics

	Survey Respondents	Massachusetts Residents or Households[a]	Logger	No Logger
n	823	6,349,097-population 2,443,580-households	120	703
Own/Rent Status				
Own	91%[b]	62%	95%[b,c]	91%[b]
Rent	4[b]	38	5[b]	4[b]
Refused	4		0[c]	5
Type of Dwelling				
Single Family House	84%[b]	52%	78%[b]	84%[b]
Multifamily[2]	14[b]	46	20[b,c]	13[b]
Mobile home, other	1[b]	2	0[b,c]	1[b]
Refused	2		3[b]	2

[a] Includes single family, attached; duplexes; townhouses; and apartments.
[b] Significantly different from MA general population at the 90% confidence level.
[c] Significantly different from households not logged in survey at the 90% confidence level.