Nexus Market Research, Inc.

# RESIDENTIAL LIGHTING MEASURE LIFE STUDY

***FINAL***

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**Submitted to:**
**New England Residential Lighting Program Sponsors**

**Submitted by:**
**Nexus Market Research, Inc.**
**RLW Analytics, Inc.**

22 Haskell Street, Cambridge, MA 02140
Phone: (617) 497-7544 Fax: (617) 497-7543
www.nexusmarketresearch.com

# Table of Contents


1 Executive Summary ..... 1
2 Introduction ..... 7
2.1 Structure of this Report ..... 7
2.2 List of Terms Used in this Report ..... 7
2.3 Current Lighting Programs in New England ..... 9
3 Sample Design, Methodology, and Measure Life ..... 10
3.1 Sample Design ..... 10
3.2 On-Site Methodology ..... 11
3.3 Potential Bias ..... 12
3.4 Decision Table for Including Products in Analysis ..... 12
3.5 Examining Survival and Failure Rates of Included Products ..... 15
3.6 Measure Life Analyses ..... 19
3.7 Parametric Regression Analysis ..... 19
4 Installation Rates for Measure Life Products ..... 22
5 Current Disposition and Use of Measure Life Products ..... 24
5.1 Location of Use ..... 24
5.2 Products That Have Not Been Installed and Are Not Traceable ..... 24
5.3 Product Disposition ..... 26
5.4 Replacement of Removed Measure Life Products ..... 27
6 Counting Products in the Home ..... 28
6.1 Socket Count of All Lighting Products ..... 28
6.2 All Lighting Products in Storage ..... 31
7 Markdown Products and Program Spillover ..... 34
7.1 Possible Markdown Products in Respondent Homes ..... 34
7.2 Coupon and Direct Install Spillover ..... 35
8 Recommendations ..... 38
Appendix A: Sample Design and Bias ..... 41
A.1 Sample Development ..... 41
A.2 Sample Design ..... 44
A.3 On-Site Methodology ..... 46
A.4 Bias Resulting from Sample Design and Methodology ..... 47
A.4.1 Potential Sources of Bias from Sampling Procedures ..... 47
A.4.2 Potential Sources of Bias from Respondent Recall ..... 48
A.5 Decision Table for Including Products in Analysis ..... 50
Appendix B: Preliminary Examination of Measure Life Data ..... 55
B.1 Examining Survival and Failure Rates of Included Products ..... 55
B.2 Product Quality over Time ..... 59
Appendix C: Measure Life Analyses ..... 61
C.1 Life Tables ..... 62
C.2 Logit Regression Models ..... 63
C.3 Parametric Regression Analysis ..... 65

Appendix D: Not Found/Not Recalled Products ..... 74
D.1 Background Information ..... 74
D.2 Ability to Recall over Time ..... 76
D.3 Location of Original Installation ..... 76
D.4 Relationship to Participants who Purchase the Most Products ..... 77
D.5 Various Analysis of Model Numbers ..... 77
D.5.1 Miscategorization as Spillover ..... 77
D.5.3 Rare Products or Incorrect Model Numbers ..... 77
D.5.3 Overlap with Most Commonly Obtained Products ..... 78

# List of Tables


Table 1–1: Recommended Estimates of Measure Life – Decimals ..... 1
Table 1–2: Recommended Estimates of Measure Life – Integers ..... 1
Table 1–3: Status of Measure Life Products for Use in Analysis ..... 3
Table 2–1: Annual Product Distribution in Massachusetts by Type and Program Component[a] ... 9
Table 3–1: Products Available for Study Sample ..... 10
Table 3–2: Distribution of Sampled CFLs, External Fixtures, and Internal Fixtures by State and Program ..... 11
Table 3–3: Categorization of Measure Life Products Based on Rules of Decision Table ..... 14
Table 3–4: Characterization of Products by Auditor's Ability to Locate Them ..... 15
Table 3–5: Coupon CFL Failure and Survival by Year of Purchase ..... 15
Table 3–6: Direct Install CFL Failure and Survival by Year of Purchase ..... 16
Table 3–7: Exterior Fixture Failure and Survival by Year of Purchase ..... 16
Table 3–8: Interior Fixtures Failure and Survival by Year of Purchase ..... 16
Table 3–9: Recommended Estimates of Measure Life – Decimals Reported ..... 20
Table 3–10: Recommended Estimates of Measure Life – Integers Reported ..... 20
Table 4–1: Product Installation Rates by Year ..... 23
Table 5–1: Location of Installed Lighting Products ..... 24
Table 5–2: Percentage of Products Respondents Did Not Recall by Quality of Product Information ..... 25
Table 5–3: Locating Interior Fixtures by Type of Fixture ..... 25
Table 5–4: Disposal Method of lighting products that broke or burned out ..... 26
Table 5–5: Disposal method of lighting products removed while still working ..... 26
Table 5–6: Replacement of Removed Lighting Products ..... 27
Table 6–1: Distribution of Lighting Products by State ..... 28
Table 6–2: Lighting Products by Location in Household ..... 29
Table 6–3: Lighting Products by Fixture Type ..... 30
Table 6–4: Lighting Products by Control ..... 30
Table 6–5: Wattage of All Installed Lighting Products ..... 31
Table 6–6: Light Bulbs in Storage ..... 32
Table 6–7: Why CFL Was Not Installed ..... 33
Table 6–8: What Bulb Will CFL Replace ..... 33
Table 7–1: Overlap of Measure Life Product Models with Markdown Models ..... 34
Table 7–2: Source of CFLs Observed in Respondents' Homes ..... 35
Table 7–3: Calculating Possible CFL Spillover Purchases ..... 36
Table 7–4: Motivation for Buying CFL Products ..... 37
Table 8–1: Recommended Estimates for Measure Life ..... 38
Table A–1: Products Listed in Databases Received from Sponsors ..... 42
Table A–2: Products Available for Study Sample ..... 43
Table A–3: Desired and Actual Completions by Year and Type of Program ..... 44
Table A–4: Distribution of Sampled CFLs, External Fixtures, and Internal Fixtures by State and Program ..... 46
Table A–5: Decision Table for Useful Life ..... 51
Table A–6: Categorization of Measure Life Products Based on Rules of Decision Table ..... 52
Table A–7: Characterization of Products by Auditor's Ability to Locate Them ..... 54

Table B–1: Coupon CFL Failure and Survival by Year of Purchase ..... 55
Table B–2: Direct Install CFL Failure and Survival by Year of Purchase ..... 55
Table B–3: Exterior Fixture Failure and Survival by Year of Purchase ..... 55
Table B–4: Interior Fixtures Failure and Survival by Year of Purchase ..... 56
Table C–1: Estimated Measure Life, Logit Regression Analysis ..... 64
Table C–2: Estimated Measure Life, Parametric Regression Analyses ..... 68
Table C–3: Estimated Measure Life of Products also Offered in Markdown Programs, Parametric Regression Analyses ..... 69
Table C–4: Recommended Estimates of Measure Life – Decimals Reported ..... 72
Table C–5: Recommended Estimates of Measure Life – Integers Reported ..... 72
Table D–1: Number and Percentage of Not Found/Not Recalled Products ..... 74
Table D–2: Percentage of Products Respondents Did Not Recall by Quality of Product Information ..... 75
Table D–3: Status of Lighting Products with Model Numbers Sometimes Found/Recalled ..... 78
Table D–4: Status of All Lighting Products, Except those Not Found/Not Recalled ..... 78

# List of Figures

Figure 3-1: Survival and Failure Rates of Coupon CFLs (Raw Data) ..... 17
Figure 3-2: Survival and Failure Rates of Direct Install CFLs (Raw Data) ..... 17
Figure 3-3: Survival and Failure Rates of Exterior Fixtures (Raw Data) ..... 18
Figure 3-4: Survival and Failure Rates of Interior Fixtures (Raw Data) ..... 18
Figure A-1: Percentage of Products Found by Auditor or Recalled by Respondent ..... 49
Figure B-1: Survival and Failure Rates of Coupon CFLs (Raw Data) ..... 57
Figure B-2: Survival and Failure Rates of Direct Install CFLs (Raw Data) ..... 57
Figure B-3: Survival and Failure Rates of Exterior Fixtures (Raw Data) ..... 58
Figure B-4: Survival and Failure Rates of Interior Fixtures (Raw Data) ..... 58
Figure B-5: Survival Rates of CFLs by Year Obtained (Raw Data) ..... 59
Figure B-6: Survival Rates of Exterior Fixtures by Year Obtained (Raw Data) ..... 60
Figure B-7: Survival Rates of Interior Fixtures by Year Obtained (Raw Data) ..... 60
Figure C-1: Cumulative Survival Rates from Life Tables ..... 63
Figure C-2: Estimated Survival Rates from Logit Regression ..... 65
Figure C-3: Estimated Measure Life of CFLs, Parametric Regression Analyses ..... 70
Figure C-4: Measure Life of Exterior Fixtures, Parametric Regression Analyses ..... 71
Figure C-5: Measure Life of Interior Fixtures, Parametric Regression Analyses ..... 71
Figure D-1: Percentage of Products Found by Auditor or Recalled by Respondent ..... 76

# 1 Executive Summary

The purpose of this study is to estimate measure life for lighting products distributed through energy efficiency programs in New England. As explained in more detail in the full study (see Section 3.7 and Appendix C), we recommend three different program-specific estimates of measure life for CFLs (coupon, direct install, and markdown[1]) and two for exterior fixtures (markdown and all other programs). These estimates and their respective confidence intervals are shown in Table 1–1 (to two decimal places) and in Table 1–2 (as integers). We do not suggest an estimate of measure life for interior fixtures as we believe the data were collected too early in their life cycle to provide a reliable estimate.

**Table 1–1: Recommended Estimates of Measure Life – Decimals**

| Product | Measure Life | 80% Confidence Interval | |
|---|---|---|---|
| | | Low | High |
| Coupon CFLs | 5.48 | 5.06 | 5.91 |
| Direct Install CFLs | 6.67 | 5.97 | 7.36 |
| Markdown CFLs (all states) | 6.82 | 6.15 | 7.44 |
| Coupon and Direct Install Exterior Fixtures | 5.47 | 5.00 | 5.93 |
| Markdown Exterior Fixtures | 5.88 | 5.24 | 6.52 |
| All Interior Fixtures | Continue using current estimates of measure life | | |

**Table 1–2: Recommended Estimates of Measure Life – Integers**

| Product | Measure Life | 80% Confidence Interval | |
|---|---|---|---|
| | | Low | High |
| Coupon CFLs | 5 | 5 | 6 |
| Direct Install CFLs | 7 | 6 | 7 |
| Markdown CFLs (all states) | 7 | 6 | 7 |
| Coupon and Direct Install Exterior Fixtures | 5 | 5 | 6 |
| Markdown Exterior Fixtures | 6 | 5 | 7 |
| All Interior Fixtures | Continue using current estimates of measure life | | |

Our definition of "measure life" is consistent with that used in the *Measure Life Report* prepared by GDS Associates for the New England State Program Working Group (SPWG).[2] "For programs delivered by program administrators in New England, Measure Life includes equipment life and measure persistence (not savings persistence).

- Equipment Life means the number of years that a measure is installed and will operate until failure, and
- Measure Persistence takes into account business turnover, early retirement of installed equipment, and other reasons measures might be removed or discontinued."

[1] Due to the diversity of program types throughout the region, we use the term "markdown" to refer to both markdown programs (offered in all the states) and buydown programs (offered in some of the states). In Massachusetts, the Negotiated Cooperative Promotions (NCPs) include both markdown and buydown programs.
[2] GDS Associates, Inc. (2007) *Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures*. Prepared for The New England State Program Working Group for use as an Energy Efficiency Measures/Programs Reference Document for the ISO Forward Capacity Market (FCM).

Specifically, our measure life estimates do not distinguish between equipment life and measure persistence; our estimates—one for each measure category—include both those products that were installed and operated until failure (i.e., equipment life) as well as those that were retired early and permanently removed from service for any reason, be it early failure, breakage, or the respondent not liking the product (i.e., measure persistence). The remainder of this executive summary provides background information about the study and highlights some of the key results and recommendations.

**Sample Development and Design**: The sample design for this study is based on the number of energy efficient lighting products distributed through energy-efficiency programs conducted in Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont (See Section 3.1 and Appendix A). For a program to be included, we needed to be able to determine the following information for a product or the person obtaining that product:

1. Knowledge that the respondent had obtained at least one energy efficient lighting product through a Sponsor's program from 2002 to 2006
2. Detailed information on the model number, manufacturer and wattage for the product in order to identify it in the home; for direct install programs, we also looked for the location of installation
3. Customer contact information

After reviewing the databases of households that had participated in various retail and direct install programs, NMR and RLW determined that only the coupon, single-family ENERGY STAR Homes and MassSAVE files contained sufficient product and resident contact information to use for the study. We drew a random sample of participants based on the type and number of products they had obtained through the programs. *We collectively refer to these sample products as the "measure life products."* Auditors visited a total of 285 homes to conduct an inventory of lighting products and a respondent survey designed to learn more about the measure life products as well as other lighting products found in the home.

**Bias Resulting from Sample Design and Methodology**: The sample design and methodology used in this study introduce several potential sources of bias (See Appendix A):

1. The lack of adequate product and customer contact information limited the sample to the coupon and a few direct-install programs while excluding products from all other Sponsor-administered lighting programs.
2. In order to complete the study in a timely and cost effective manner, the later on-site surveys targeted homes with large numbers of fixtures. This decision resulted in the unintended inclusion of a disproportionate number of electricians, contractors, and landlords, as they had purchased large numbers of fixtures to install in locations other than their own homes. Because they installed these products at different addresses, we were unable to verify the disposition of many of these products. Furthermore, respondents with numerous products were less likely to recall the disposition of at least some of them (See Appendix D).
3. Given the amount of time that passed between the household obtaining the lighting products and being contacted for this study, inaccurate customer recall of products that the auditor did not personally observe accounts for the majority of products excluded from the analysis and presents a major source of potential bias

4. Because we contacted respondents at the phone number given at the time of participation, the resulting sample included only those who had not moved or changed their phone number in at least one and up to six years. This likely means that low-income households, renters, and younger adults are not well represented in the sample.

While we recognize that the potential for bias exists, we cannot say whether such bias would produce higher or lower estimates than the ones we present here. Moreover, we find no evidence of bias across states or Sponsors.

**Characterizing Products as Survived, Failed, or Excluded**: In order to estimate measure life, we had to classify individual products as having "survived" or "failed" for a specific period of time. In cooperation with the Sponsors, we developed a "Decision Table" to guide the classification of products into one of three categories: 1) survived, 2) failed or 3) excluded (See Section 3.4 and Appendix A). For a product to be classified as "survived" the auditor typically had to confirm its continued installation and operation visually. An exception to this was the inclusion of products reported installed in rentals, second homes, and businesses if the respondent was in the position of knowing the current status of the product. "Failed" products are those that burned out, broke, or were permanently removed from service, including those that broke or failed and were returned to the store. We excluded products: that could not be found (accounting for the majority of excluded products, see Appendix D); that were reported installed but the respondent was not in the position to know if the product remained in place (e.g., by a contractor); that were installed outside of New England; that were being stored for future use; and that had been returned to the store before the product failed (e.g., a CFL may not have fit a fixture or the customer decided they did not like a fixture) or given away. Table 1–3 summarizes these classifications, but see Section 3.4 and Appendix A for more detail.

**Table 1–3: Status of Measure Life Products for Use in Analysis**

| Product Status | CFLs | | Fixtures | |
|---|---|---|---|---|
| | Coupon | Direct Install | Exterior | Interior |
| Survived | 48% | 56% | 37% | 55% |
| Failed | 20% | 14% | 17% | 6% |
| Excluded from Analysis | 32% | 31% | 46% | 39% |
| Total Number of Products | 695 | 441 | 215 | 397 |

**Measure Life Analysis**: We relied on three types of "survival analyses" to estimate the measure life of the products distributed through the coupon and direct install programs under consideration (See Section 3.6, Section 3.7 and Appendix C):

Method 1: Life Tables
Method 2: Logit Regression
Method 3: Parametric Regression Models of Survival Analysis[3]

We chose estimates resulting from parametric regression analysis. According to our results, the measure life of CFLs (coupon, direct install, and markdown) falls between five and one-half and seven years, while that for exterior fixtures (coupon, direct install, and markdown) is between

[3] We examined five types of Parametric Regression models in this analysis.

five and one-half years and six years (Table 1–1). However, we do not believe that the data or results are adequate for predicting the measure life of interior fixtures because this study was conducted too early in their lifecycle. The measure life data also provide some indication of increased survival rates over time for CFLs, perhaps as a result of improved product quality, although the small sample size and limited number of failures in recent years curtail our ability to conduct meaningful statistical analyses to verify improved quality.

The reader will note that we provide an estimate of measure life for markdown CFLs and exterior fixtures. We did not include the lighting markdown and buydown programs (collectively referred to as "markdown" programs in this document since not all Sponsors used the buydown approach) in the sample of measure life products due to a lack of participant contact information. Even so, markdown programs account for the vast majority of lighting products distributed through the Sponsors' programs. For this reason, we conducted analyses on the subset of products with model numbers obtained through the coupon or direct install programs that were also distributed through markdown programs in order to provide an estimate of measure life for the markdown products (Section 3.7). We supply these estimates with three important caveats: 1) the population who purchases markdown products may differ from those who take part in coupon or direct install programs, 2) not all markdown model numbers were represented in the sample of measure life products, and 3) the distribution and usage of products actually purchased in the markdown programs may vary from what we observed from these products obtained through coupon and direct install products. We believe it would be wise to conduct a follow-up study of the measure life of markdown products in the near future.

**Measure Life Product Use and Disposition**: Most of the measure life CFLs and many interior fixtures were found installed in the living room (22% to 23%), bedroom (16% to 24%), kitchen and dining room (11% to 19%), and the basement (9% to 11%) of respondents' homes (See Section 5.1). Interior fixtures were most commonly installed in foyers and hallways (32%). Only four percent of coupon CFLs and one percent of all other products were found in storage, likely reflecting the fact that many of these products had been in the respondents' home between 18 months and six years by the time we visited (See Section 6.2). Most of the products had likely been installed—or misplaced—by the time we conducted the on-sites. It is also the case that direct install products are typically installed by the auditor during the visit to the customer's home. Alternatively, it is possible that some of the stored CFLs are measure life products on which we had incomplete or perhaps incorrect information from the database, or that respondents confused them with products they had obtained outside the coupon or direct install programs. Respondents usually replace burned out or broken CFLs with new CFLs (59%), but broken energy-efficient fixtures are more commonly replaced with regular fixtures and incandescent bulbs (59%) (See Section 5.4). Once CFLs or fixtures burn out, most participants throw them away in the trash (84%). Few respondents report recycling the CFLs (14%). Previous research we have conducted indicates that few people are aware of the mercury in CFLs, although recent media attention and Sponsor education campaigns have raised awareness.[4] As a result, most consumers throw the CFLs away as they would other bulbs. However, it is also the case that to

[4] NMR (2008) *Telephone Survey Results for Market Progress and Evaluation Report (MPER) 2007 Massachusetts ENERGY STAR Lighting Program.* Submitted to National Grid, Cape Light Compact, NSTAR Electric Company, Western Massachusetts Electric Company, and Unitil. Draft April 4, 2008.

recycle CFLs in many of the states participating in this study, users must save broken or burned out bulbs and take them to hazardous waste drop-off sites (often associated with towns or municipalities), usually on specific dates.

**Identification of Markdown and Spillover Products**: A secondary objective of this study is to estimate the number of products currently in respondents' homes that may have potentially been purchased through lighting markdown programs run by the Sponsors. We matched a list of model numbers from Energy Federation Incorporated (EFI) of all markdown products offered in New England (with a separate list for Vermont) with all the measure life products currently installed in the 285 households (See Section 7.1). We also asked respondents how much they paid for the CFLs and fixtures and where they were purchased. Only two fixtures appear to be markdown products, but a total of 21% of all CFLs in respondents' homes (942 in total, or 3.3 per home) are likely markdown purchases. Note that in 2006 markdown products accounted for about 85% of CFLs distributed through Massachusetts programs, but because the participants in the measure life programs have obtained products through coupon or direct install programs, they may have had less need to buy markdown products than households that are not obtaining CFLs for the first time.

Finally, we estimated spillover for the coupon and direct install programs (See Section 7.2). We limited the estimates to non-markdown CFLs that were purchased after the respondents' participation in the coupon or direct install programs. Respondents had to be aware of the program and to state that their participation in the coupon or direct install program strongly influenced their decision to purchase the non-program products. In total, there are 892 likely spillover CFLs found in the homes of coupon participants (4.9 per coupon household) compared to 695 coupon CFLs—amounting to spillover of 128%—and 355 likely spillover CFLs found in the homes of direct install participants (3.4 per direct install household) compared to 441 direct install CFLs—amounting to spillover of 81%.

However, it should be noted that our estimate of spillover does not take into account program influences of which the respondent is not aware, such as the fact that the success of such programs has increased the availability and lowered the price of CFLs. Furthermore, it does not include any program-induced purchases of CFLs that are no longer in their homes (e.g., they may have burned out, been given away, etc.). Taking these other factors into account would tend to increase the spillover rate. In contrast, it is also likely that the markdown program is responsible for some of the spillover that our methodology attributes to direct install or coupon programs.

**Recommendations**: The findings from this analysis lead to the following recommendations for the Sponsors:

- Adopt the measure life estimates presented in Table 1–1
- To the extent possible, collect the following information in direct install programs: product type, manufacturer, model number, fixture type, wattage, room/location of installation, date of installation, and any other product as well as customer information including name, address, and phone number.
- Conduct a measure life study of interior fixtures in the future, as our study occurred too early in their life cycle to provide reliable estimates
- Conduct a process evaluation to examine problems with tracking databases; consider a study that tracks new coupon purchases over time in order to ascertain what happens to products after they leave the stores.
- Conduct a long-term measure life study relying on a panel-based approach and using a sample drawn in part from the current Markdown Impact Study being conducted for Sponsors in Connecticut, Massachusetts, Rhode Island, and Vermont and marking the appropriate products with a sticker or permanent marker for future identification.
- Continue current support for quality assurance efforts.

**Additional Topics**: This report also addresses the following topics:

- Installation rates of measure life CFL products included in this study (See Section 4)
- Analysis of all lighting products currently installed in the participants' homes (See Section 6.1)
- Analysis of all lighting products currently placed in storage (See Section 6.2)