EMI CONSULTING

Connecticut Energy Efficiency Board
C1644 EO Net-to-Gross Study

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FINAL REPORT

Presented

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energize CONNECTICUT CT

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ABSTRACT

Energy Opportunities (EO) Program Net to Gross Study Abstract

The CT EEB sought a robust and accurate evaluation of the net influence of the Energy Opportunities (EO) program on the market for energy efficiency retrofits to use for regulatory reporting (by updating Program Savings Document (PSD) NTG values) and future program planning. To accomplish their objectives, the EEB contracted with EMI Consulting (hereafter referred to as "the evaluation team") to complete this evaluation.

The primary objective of the evaluation of the EO program was to estimate a net-to-gross (NTG) ratio by estimating free-ridership, like-spillover, and unlike-spillover from the custom and prescriptive components of the EO program, disaggregated for each of the nine electric and five gas measure categories in the EO program (Controls, Cooling, Custom, Heating, Lighting, Motors, Process, Refrigeration, and Other for electric; Controls, Custom, Heating/DHW, Process and Other for natural gas). The evaluation team also estimated a NTG ratio for the upstream lighting Initiative. This Initiative is separate from the EO program, but is included in the program's reporting. These results presented in the form of end-use-level estimates of free-ridership and spillover, as well as NTG ratios.

To develop the NTG ratios, the evaluation team assessed the influence of the program on various market actors' purchasing behaviors and quantified the proportion of gross program savings that are attributable to the program. To discern the influence of the EO program on purchase decisions and vendor business practices, the evaluation team relied on self-reported data from a variety of relevant market actors including end-users, contractors, and distributors. We collected the self-reported data by conducting telephone interviews with 80 EO program participants, representing 395 electric projects and 70 gas projects. In addition to conducting interviews with EO program participants, the evaluation team also conducted interviews with design professionals and vendors identified by customers as being influential. Finally, as part of this study, the evaluation team also conducted survey research to establish free-ridership and spillover estimates for the Energize CT upstream lighting initiative.

As part of this study, the evaluation team recommends that the EEB update the 2020 PSD with the NTG values found in this study as outlined in the tables below. This includes adding a separate NTG value for electric Controls and applying the program-level natural gas results to all natural gas measures (as was done in 2011). This includes a NTG value of 83% for screw-based LEDs and 91% for linear LEDs as part of the upstream lighting program initiative.

Energy Opportunities NTG Study Results by End-use and Fuel type – Electric

Sample Stratum Electric	Free-ridership	Like-spillover	Unlike Spillover	NTG Ratio	+/- Confidence Interval (90%)	+/- Confidence Interval (80%)
Controls	0.39	0.11	0.03	75%	N/A	35%
Cooling	0.12	0.05	0.00	93%	N/A	3%
Custom	0.23	0.00	0.00	77%	N/A	9%
Heating	0.14	0.07	0.00	93%	N/A	11%
Lighting	0.11	0.05	0.00	94%	4%	N/A
Motor	0.12	0.01	0.02	91%	N/A	6%
Other	0.00	0.00	0.00	100%	N/A	0%
Process	0.12	0.35	0.00	124%	N/A	7%
Refrigeration	0.13	0.00	0.00	88%	N/A	2%
Upstream Lighting (Screw-based Only)	0.40	0.23	N/A	83%	N/A	14%
Overall Electric	0.12	0.06	0.003	94%	3%	**N/A**

Energy Opportunities NTG Study Results by End-use and Fuel type – Natural Gas

Sample Stratum Electric	Free-ridership	Like-spillover	Unlike Spillover	NTG Ratio	+/- Confidence Interval (90%)	+/- Confidence Interval (80%)
Controls	0.31	0.02	0.00	71%	N/A	28%
Custom	0.37	0.02	0.00	65%	N/A	12%
Heating / DHW	0.16	0.02	0.00	86%	N/A	5%
Other	0.00	0.00	0.00	100%	N/A	0%
Process	0.14	0.12	0.04	102%	N/A	13%
Overall Gas	0.19	0.06	0.02	89%	5%	**N/A**

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EXECUTIVE SUMMARY

Introduction

This report presents the results from the Energy Opportunities Net-to-Gross Study conducted by EMI Consulting on behalf of the Connecticut Energy Efficiency Board (EEB). The Executive Summary provides a high-level description of the purpose of the evaluation, methods used, results, and recommendations for reducing free-ridership rates in the future. Detailed methodology and results are contained in the body of the report following this Executive Summary.

Description of Study

The EEB sought a robust and accurate evaluation of the net influence of the Energy Opportunities (EO) program on the market for energy efficiency retrofits to use for regulatory reporting (by updating Program Savings Document NTG values) and future program planning. To accomplish their objectives, the EEB contracted with EMI Consulting (hereafter referred to as "the evaluation team") to complete this evaluation.

The primary objective of the evaluation of the EO program was to estimate a net-to-gross (NTG) ratio by estimating free-ridership, like-spillover, and unlike-spillover from the custom and prescriptive components of the EO program, disaggregated for each of the nine electric and five gas measure categories in the EO program (Controls, Cooling, Custom, Heating, Lighting, Motors, Process, Refrigeration, and Other for electric; Controls, Custom, Heating/DHW, Process and Other for natural gas). The evaluation team also estimated a NTG ratio for the upstream lighting program. This program is separate from the EO program, but is included in the program's reporting. These calculations are presented in the form of end-use-level estimates of free-ridership and spillover, as well as NTG ratios.

Methodology

To develop the NTG ratios, the evaluation team assessed the influence of the program on various market actors' purchasing behaviors and quantified the proportion of gross program savings that are attributable to the program. The differences between gross and net savings are typically a function of free-ridership and spillover.

For the purpose of this analysis, we define a *free-rider* as a program participant who received an incentive or other assistance though an energy efficiency program, but who would have installed the same high-efficiency measure type on their own and at the same time had the program not been offered. A program's *free-ridership rate* is therefore the percentage of program savings attributed to free-riders. For a participant to be considered a free-rider, it is assumed that the program had no direct or indirect influence on their decision to install an energy-efficient measure type. As a result of this, none of the energy savings from the energy-efficient measure installed should be attributable to the efforts of the program. *Spillover* is defined as additional energy-efficient equipment adopted by a customer due to program influences, but without any financial or technical assistance from the program. *Like-spillover* refers to situations where a customer installed energy efficiency measures through the program, and then installed additional measures of the same type due to program influences, but without receiving an incentive. *Unlike-spillover* refers to situations where the customer installs other types of energy-efficient measures outside of the program (i.e., they do not receive any incentives) but past experience with the EO program influenced them to do so. Quantified spillover savings that are attributed to the program can offset any estimated free-ridership among participants.

To discern the influence of the EO program on purchase decisions and vendor business practices, the evaluation team relied on self-reported data from a variety of relevant market actors including end-users, contractors, and distributors. We collected the self-reported data by conducting telephone interviews with 80 EO program participants, representing 395 electric projects and 70 gas projects across the 2017-2018 program years, to establish free-ridership and spillover estimates for each of the nine electric and five gas measure categories in the EO program (Controls, Cooling, Custom, Heating, Lighting, Motors, Process, Refrigeration, and Other for electric; Controls, Custom, Heating/DHW, Process and Other for natural gas). These end-use categories are similar to those found in Connecticut's 2018 Program Savings Document (PSD), which reflects those from the previous study of the NTG ratios for this program conducted in 2012 of the 2011 program year.[1,2]

In addition to conducting interviews with EO program participants, the evaluation team also conducted interviews with design professionals and vendors identified by customers as being influential during the decision to install energy-efficient equipment through the EO program. If a survey participant designated the design professional or vendor as more influential in the decision than the participant, results from the vendor surveys rather than the participant surveys were used to estimate free-ridership.

Our approach aligns with the methodology outlined in the Massachusetts NTG framework, and our research uses the same battery of questions and scoring design.[3] This provides the EEB with consistent results and assurances that any changes over time can be attributed to changes in the market or program delivery and not to changes in the methodology. This approach is also generally consistent with past NTG methodology used in Connecticut as part of the 2011 evaluation of the EO program. The only significant variance is this study does not include an estimate of non-participant spillover (NPSO) due to limited evaluation resources. As such, our estimate may be under-reporting program influence. However, as the past Connecticut NTG study found no evidence of significant non-participant spillover, we believe no further adjustment is necessary.

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[1] The evaluation team added a Controls category for electric and added Custom, Heating and Domestic Hot Water, and Other categories for Gas. These adjustments were based on the frequency of measures in the data and aimed at providing greater nuance in net-to-gross estimates.
[2] Tetra Tech (October 2012). Commercial and Industrial Electric and Natural Gas Programs Free-ridership and Spillover Study. Prepared for the Connecticut Energy Efficiency Fund.
[3] Tetra Tech (April, 2011). Cross-Cutting Net to Gross Methodology Study for Residential Programs – Suggested Approaches (Final). Prepared for the Massachusetts Program Administrators.

As part of this study, the evaluation team also conducted survey research to establish free-ridership and spillover estimates for the Energize CT upstream lighting initiative. Estimates for the upstream element of the program followed the methodology developed for the Massachusetts Program Administrators and Massachusetts Energy Efficiency Advisory Council (EEAC) in 2018[4] to the extent that the program data allowed. We conducted interviews with 14 program end-users and 4 program distributors to estimate a NTG ratio for this component of the program. A detailed explanation of the methods the evaluation team utilized is provided in Chapter 2.

Results

The evaluation team determined end-use level results for the following:

- Free-ridership: The fraction (usually expressed as a percent) of gross program savings that would have occurred in the absence of the EO program.
- Spillover: Savings attributable to the EO program, but in addition to the program's gross (tracked) savings. Spillover includes the effects of participants who install additional energy-efficient measures as a result of what they learned in the program.
- Combined NTG ratios: The ratio of net savings to the gross savings (for a measure or program). Net-to-gross is usually expressed as a percent. Net-to-gross ratios include elements of free-ridership and spillover.

Table ES-1-1 and Table ES-1-2 below present these results below along with the associated confidence interval (cells shaded green indicate that our study met the desired target for precision). The highest NTG ratios were estimated for the Process (electric) and Process (gas) end-use categories. Controls (electric) and Custom (gas) end-use categories had the lowest estimated NTG ratios. Descriptions for the types of projects included in each sample stratum are included in Appendix E.

Table ES-1-1. Energy Opportunities NTG Study Results by End-use and Fuel type - Electric

Sample Stratum Electric	Free-ridership	Like-spillover	Unlike Spillover	NTG Ratio	+/- Confidence Interval (90%)	+/- Confidence Interval (80%)
Controls	0.39	0.11	0.03	75%	N/A	35%
Cooling	0.12	0.05	0.00	93%	N/A	3%
Custom	0.23	0.00	0.00	77%	N/A	9%
Heating	0.14	0.07	0.00	93%	N/A	11%
Lighting	0.11	0.05	0.00	94%	4%	N/A
Motor	0.12	0.01	0.02	91%	N/A	6%
Other	0.00	0.00	0.00	100%	N/A	0%

[4] DNV-GL (July, 2018). Massachusetts Program Administrators and Energy Efficiency Council. Massachusetts C&I Upstream Lighting Net-to-Gross Study - Draft Report.

Process	0.12	0.35	0.00	124%	N/A	7%
Refrigeration	0.13	0.00	0.00	88%	N/A	2%
Upstream Lighting (Screw-based Only)	0.40	0.23	N/A	83%	N/A	14%
Overall Electric	0.12	0.06	0.003	94%	3%	**N/A**

Table ES-1-2. Energy Opportunities NTG Study Results by End-use and Fuel type – Natural Gas

Sample Stratum Electric	Free-ridership	Like-spillover	Unlike Spillover	NTG Ratio	+/- Confidence Interval (90%)	+/- Confidence Interval (80%)
Controls	0.31	0.02	0.00	71%	N/A	28%
Custom	0.37	0.02	0.00	65%	N/A	12%
Heating / DHW	0.16	0.02	0.00	86%	N/A	5%
Other	0.00	0.00	0.00	100%	N/A	0%
Process	0.14	0.12	0.04	102%	N/A	13%
Overall Gas	0.19	0.06	0.02	89%	5%	**N/A**

Finally, the evaluation team compared the results from this study to the EO program NTG ratio estimates from NTG study conducted in Connecticut in 2011. Table ES-1-3 presents these results in detail. As indicated in the table, the overall program rates are nearly identical for the electric component of the program and decrease by 12% for the gas program from 2011 to 2017. When viewed at the end-use level, these ratios for the most part only differ slightly. Notable differences between the 2011 and 2017 NTG estimates include the electric Process category, which increased 35% (from 89% to 124%), the electric refrigeration category, which decreased 16% (from 104% to 88%), and the Gas Process End-Use, which decreased from 179% to 99% in 2017. The table also compares Connecticut results with recent Massachusetts results. Detailed evaluation results along with comparisons to past results in both Connecticut and Massachusetts can be found in Chapter 3 and Chapter 4.

Table ES-1-3. Energy Opportunities NTG ratios Comparisons

End-Use	Fuel Type	2011 CT NTG Ratio	2017 CT NTG Ratio	Change	2015 C&I MA NTG Ratios
Controls	Electric	100%	75%	-25%	N/A
Cooling	Electric	80%	93%	+13%	88%
Custom	Electric	76%	77%	+1%	101%
Heating	Electric	85%	93%	+8%	88%
Lighting	Electric	96%	94%	-2%	97%
Motor	Electric	N/A	91%	N/A	113%
Other	Electric	97%	100%	+3%	N/A
Process	Electric	97%	124%	+27%	96%
Refrigeration	Electric	97%	88%	-9%	90%
Upstream Lighting (Screw-based Only)	Electric	N/A	83%	N/A	82%[5]
Overall Electric		93%	94%	+1%	96%
					2018 C&I MA NTG Ratios
Controls	Gas	69%	71%	+2%	N/A
Custom	Gas	N/A	65%	N/A	86%
Heating / DHW	Gas	83%	86%	+3%	83% / 89%[6]
Other	Gas	N/A	100%	N/A	81%
Process	Gas	189%	102%	-87%	89%
Overall Gas		101%	89%	-12%	84%

Note: The evaluation team added Custom and Other categories for Gas. We combined HVAC and Domestic Hot Water as part of the sample design. These adjustments were based on the frequency of measures in the data and aimed at providing greater nuance in net-to-gross estimates.

Recommendations

As part of the Energy Opportunities NTG study, the evaluation team analyzed key drivers of the program's NTG estimates and identified ways to increase NTG in the future. These key drivers and their respective recommendations are presented below. In addition, we have provided several recommendations on how to improve future NTG studies in Connecticut, based on our experiences with this research effort.

1. The evaluation team found relatively stable NTG ratios for the EO program when compared to both the past research in Connecticut and recent research in Massachusetts. While our research did not include NPSO estimates, past research in Connecticut also did not identify any NPSO savings for the EO program.

[5] From the evaluation of 2012 Bright Opportunities evaluation in Massachusetts.
[6] The 2018 Massachusetts Study assessed Heating and DHW separately.

- Recommendation 1: Update the 2020 PSD with the NTG values found in this study. This includes adding a separate NTG value for electric Controls and applying the program-level natural gas results to all natural gas measures (as was done in 2011). By applying NTG values at the program level for natural gas measures, it mitigates the impact of outliers present in the small sample size. This includes a NTG value of 83% for screw-based LEDs and 91% for linear LEDs as part of the Upstream Lighting program component.[7]

- Recommendation 2: For the 2021 and 2022 Upstream Lighting program, apply prospective NTG based on expected changes in the lighting market. Based on this study and studies in Massachusetts, the evaluation team recommends a NTG value of 73% for screw-based LEDs and 84% for linear LEDs in 2021. Similarly, we recommend that the PSD include a NTG value of 63% for screw-based LEDs and 77% for linear LEDs in 2022.

2. The EO program is accelerating adoption of energy-efficient equipment and increasing the scope of projects. Most participants indicated that they likely would have installed some energy-efficient equipment without the program, but at a later date or in a smaller quantify and were greatly influenced by previous participation.

    - Recommendation 3: **Leverage upcoming process evaluations to further explore effective channels for accelerating equipment adoption (focusing on lighting and refrigeration based on survey responses regarding project timing).** While this study identified that the EO program is accelerating adoption, we recommend that upcoming process evaluation studies examine what specific channels are most effective at influence customers.

3. Previous program participation adjustment scores had a noticeable positive impact on the program's free-ridership rate. In the downstream survey, participants were asked a series of four questions to gauge the effect past program participation had on their decision-making process. Based on the number of questions a respondent answered affirmatively, their free-ridership rate was reduced 75%, 37.5%, or not at all. These reductions were made to account for the effect positive program experiences had on participants' decisions to install or implement energy-efficient equipment through the program. On average, 53% of the electric projects and 59% of the gas projects were influenced by past participation in the EO program, increasing their overall NTG ratio. This demonstrates that previous program participation has a large influence over future program participation and that customers are likely to be repeat program participants after their initial participation and may not have participated had they not had previous positive experience with the program.

    - Recommendation 4: Leverage relationships with past program participants to encourage future program participation. Program participants indicated in the

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[7] Note that this value is based on secondary research from parallel studies in Massachusetts as the end-users who participated in the sample did not purchase any linear lighting fixtures, they were only asked questions regarding their screw-in bulb purchases.

survey that they see utility program staff as a trusted resource for unbiased information, including on key financial decision-making factors. Program staff should continue to follow-up with past program participants and encourage them to find opportunities to upgrade or install energy-efficient equipment through the program. In addition, these relationships with repeat participants should be explored in upcoming process evaluations.

4. The majority of program participants (61%) learned about the program through a third party, such as their contractor, a co-worker, or a design professional.

    - Recommendation 5: Continue to market to targeted trade partners, and increase marketing tactics specifically towards potential program participants as it seems that is not the way most participants found out about the program. While the program appears to be successful marketing to third party contractors, vendors, or design professionals, program staff should increase marketing to program participants to increase program awareness. Channel awareness should be considered as an evaluation objective for upcoming process evaluations.

5. The evaluation team experienced difficulties completing the interview targets established in the original sample plan. The evaluation team attributes these difficulties to two primary factors: (1) the lag between project completion and the survey and (2) the end-use breakdown. Some participants were interviewed up to 18 months after their project was completed. This lag (combined with missing contact information) made identifying the decision-maker difficult and may have also introduced error associated with the participants' recall of the decision. In general, the further a study is conducted from the decision-point, the less likely the respondent will be able to accurately recall all of the point of influence from the EO program. In addition, the focus on specific end-uses in our design created a complicated sample plan, because many end-uses have very small populations (fewer than 20 participants).

    - Recommendation 6: Implement rolling surveys and an aggregated sampling plan. To improve overall participant response, the evaluation team recommends two options. First, we recommend that the EEB consider a "rolling" NTG assessment in which participants provide self-report responses on a more frequent basis. This would improve overall response count and decrease recall bias associated with the self-reported program influence. Second, we recommend exploring whether it may be more appropriate to focus on delivery method, including downstream prescriptive, downstream custom, and upstream models as the program delivery model may be the key NTG ratio determinant not the end-use. This aggregation may allow for larger populations from which to establish representative sampling frames.

    - Recommendation 7: Collect end-user data for all upstream program participants. To improve overall data collection, the evaluation team recommends collecting customer contact information for upstream program participants if the design remains point-of-sale. If buy-downs move further upstream, consider requiring sales data from distributors or manufacturers to conduct a market-based analysis of impact on lighting sales.

- Recommendation 8: Improve end-user contact information for all participants. Based on the evaluation team's review of the contact data, some participants had either 1-800 lines or fabricated telephone numbers (e.g., (123) 456-7890) as their contact information. This type of contact information inhibits our ability to reach project contacts and threatens the validity of these estimates. We recommend that PAs conduct periodic QA/QC reviews of these contact fields to ensure that quality information is being collected. In response to this report, both PAs confirm that the amount of end-user data collected through distributors has increased.

1. INTRODUCTION

The following document provides a summary of the results from the Energy Opportunities Net-to-Gross Study conducted by the evaluation team on behalf of the Connecticut Energy Efficiency Board (EEB). The EEB sought a robust and accurate evaluation of the net influence of the Energy Opportunities (EO) program on the market for energy retrofits to use for regulatory reporting (by updating Program Savings Document NTG values) and future program planning. To accomplish their objectives, the EEB contracted with the evaluation team to complete this evaluation. The primary objective of the evaluation of the EO program was to estimate a net-to-gross (NTG) ratio by estimating free-ridership, like-spillover, and unlike-spillover from the custom and prescriptive components of the EO program, disaggregated for each of the nine electric and five gas measure categories in the EO program (Controls, Cooling, Custom, Heating, Lighting, Motors, Process, Refrigeration, and Other for electric; Controls, Custom, Heating/DHW, Process and Other for natural gas). The evaluation team also estimated a NTG ratio for the upstream lighting component of the program. The upstream lighting program is separate from the EO program, but results for both programs are reported together.

The NTG ratios are presented in the form of end-use-level (including the upstream lighting program) estimates of free-ridership and spillover. This chapter includes an overview of the program, study objectives, the evaluation approach, and describes the organization of this report.

1.1 Program Overview

The Energy Opportunities (EO) program is the flagship commercial and industrial (C&I) program for the EEB and is administered by Eversource and United Illuminating. The program provides Connecticut businesses with financial incentives and technical assistance to encourage the replacement of functioning but outdated equipment with high-efficiency counterparts. To do this, the program provides downstream incentives for equipment sold directly to end-users. The program also provides an upstream incentive to distributors to reduce the cost of high-efficiency lighting equipment at point-of-sale.

Broadly, the EO program goals include (1) leveraging market research and customer data to customize program offerings to meet C&I customers' individual needs and (2) encouraging program administrators (PAs) to develop long-term relationships with customers, moving from "one-and-done" replacements to more comprehensive and deeper multi-year approaches. From a savings perspective, the EO program is very successful. In addition, the upstream lighting program offers incentives available through the Connecticut Energy Efficiency Fund to lighting retailers and distributors to offset the higher price of LED equipment through a point-of-sale rebate. This makes otherwise more expensive LED fixtures and lamps a cost-effective and energy-saving choice for consumers.

As of 2018, both PAs achieved their demand savings, annual energy savings, and lifetime energy savings program goals. Table 1-1 displays the total number of projects and total savings values for the EO program in 2017.

Table 1-1. 2017 EO Total Projects and Savings by Fuel Type and End-use

Sample Stratum **Electric**	Population (Project Level)	Total Savings (kWh)
Controls	43	2,947,223
Cooling	153	12,980,074
Custom	89	5,316,081
Heating	39	1,885,558
Lighting	2,851	254,580,178
Motor	75	7,220,257
Other	9	347,383
Process	66	12,424,185
Refrigeration	120	12,092,573
Upstream Lighting	NA	2,483,565
Overall Electric	**3,445**	**312,277,077**
Gas		(MCF)
Controls	53	250,632
Custom	40	562,936
Heating/DHW	226	1,578,666
Other	8	49,081
Process	49	1,586,902
Overall Gas	**376**	**4,028,217**

1.2 Study Objectives

The overall objective of this evaluation was to present the EEB with estimates to quantify the net impacts of the program and provide recommendations to decrease free-ridership in the future. These calculations are presented in the form of end-use-level and overall program estimates of free-ridership and spillover as well as NTG ratios. The evaluation team also sought to understand the decision-making and project implementation processes of the EO program.

1.3 Evaluation Approach

To develop the NTG ratios, the evaluation team assessed the influence of the program on various market actors' energy use behaviors and quantified the proportion of gross program savings that is attributable to the program. The differences between gross and net savings are typically a function of free-ridership and spillover. The generalized equation the evaluation team used to compute the final NTG ratios for the EO program is shown below in Equation 1-1.

Equation 1-1. Generalized Equation for Computing Net-to-Gross Ratios (NTGRs)

$$NTG = 1 - Freeridership + Participant\ Spillover$$

In order to capture the richness inherent in program attribution research, the evaluation team focused on moving beyond viewing free-ridership and spillover as singular concepts. To accomplish this, we have summarized total, partial, and deferred free-ridership, where applicable. Likewise, instead of just looking at like-spillover, the evaluation team has also summarized unlike-spillover. Participant "like" spillover occurs if a customer installed energy efficiency measures through the program, and later decided to install additional measures of the same type outside of the program due to program influences. Participant "unlike" spillover refers to a situation where a customer was influenced through the program to install additional energy efficiency equipment, but the equipment they install is not incented by the program (i.e., unreported savings). Including unlike-spillover allows for a less conservative approach to estimating total program spillover. Note the evaluation team did not calculate nonparticipant spillover due to limited evaluation resources and the limited evidence of NPSO in the last evaluation study. We discuss the influence this may have on final estimates as part of the results section.

To discern the influence of the EO program on purchase decisions and vendor business practices, the evaluation team relied on self-reported data from a variety of relevant market actors including end-users, contractors, and distributors. Relying on self-reported responses of program influence is considered standard practice and aligns with both past methods in Connecticut and the surrounding region. While potential biases can be introduced (e.g., recall and social desirability bias), these can be mitigated through rigorous research design.

We collected the self-reported data by conducting telephone interviews with 80 distinct EO program participants, representing 395 electric projects and 70 gas projects, to establish free-ridership and spillover estimates for each of the nine electric and five gas measure categories in the Energy Opportunities program (Controls, Cooling, Custom, Heating, Lighting, Motors, Process, Refrigeration, and Other for electric; Controls, Custom, Heating/DHW, Process and Other for natural gas). These end-use categories are similar to those found in Connecticut's 2018 Program Savings Document (PSD).[8] The number of completed interviews by end-use category are shown below in Table 1-2. Note that the total number of interviews by end-users is greater than the total distinct number of interviews, because the majority of respondents were interviewed for two end-use categories.

[8] The evaluation team added a Controls category for electric and added Custom, Heating and Domestic Hot Water, and Other categories for Gas. These adjustments were based on the frequency of measures in the data and aimed at providing greater nuance in net-to-gross estimates.

Table 1-2. Downstream Interviews by End-use

End-Use	Fuel Type	Number of Interviews
Controls	Electric	5
Cooling	Electric	9
Custom	Electric	9
Heating	Electric	3
Lighting	Electric	22
Motor	Electric	8
Other	Electric	4
Process	Electric	11
Refrigeration	Electric	4
Overall Electric		75
Controls	Gas	4
Custom	Gas	3
Heating / DHW	Gas	12
Other	Gas	1
Process	Gas	3
Overall Gas		23

In addition to conducting interviews with EO program participants, the evaluation team also conducted interviews with six design professionals and vendors identified by customers as being influential during the decision to install energy efficient equipment through the EO program. Significant influence is defined as a rating of a 7 or higher on a 0 ("no influence") to 10 ("a great deal of influence") scale. Using this methodology, 12 such interviews were triggered out of 20 survey respondents who identified a third-party design professional or vendor responsible for recommending their participation in the program. Of the seven design professionals who agreed to a further interview, six identified themselves as influential enough in project design and completed the full follow-up question battery. If a survey participant designated the design professional or vendor as more influential in the decision than the participant, results from the vendor interviews rather than the participant interviews were used to estimate free-ridership.

Our approach aligns with the methodology outlined in the Massachusetts NTG framework and our research uses the same battery of questions and scoring design.[9] This provides the EEB with consistent results and assurances that any changes over time can be attributed to changes in the market or program delivery and not to changes in the methodology. This approach is also generally consistent with past NTG methodology used in Connecticut as part of the 2011 evaluation of the EO program. The only significant variance is this study does not include an estimate of non-participant spillover (NPSO) due to limited evaluation resources. As such, our

[9] Cross-Cutting Net to Gross Methodology Study for Residential Programs – Suggested Approaches (Final). Prepared for the Massachusetts Program Administrators. July 2011.

estimate may be under-reporting program influence. We discuss this limitation in our results section.

As part of this study, the evaluation team also conducted survey research to establish free-ridership and spillover estimates for the Energize CT upstream lighting initiative. Initially, the evaluation team was uncertain whether necessary data would be available to contact both distributors and program participants. However, we were able to identify participant data and conducted interviews with 14 program end-user participants and 4 program distributors to estimate a NTG ratio for this component of the program.

1.4 Report Organization

The following chapters organize the evaluation findings into several components: methods, detailed results, and recommendations. Chapter 2 discusses the methods the evaluation team employed in order to conduct the evaluation. Chapter 3 reviews the results of the NTG analysis for both the downstream and upstream components of the EO program. Conclusions and recommendations are presented in Chapter 4. Detailed methodology information, evaluation plans, and survey instruments can be accessed in this report's appendices.

2. METHODS

This chapter summarizes the methods used to estimate NTG ratios for the EO program. The overall NTG methodology follows the standardized methodology developed for Massachusetts PAs in 2011, revised in 2014[10] and refined in 2018.[11] To support this research effort, the evaluation team collected self-report data from four main data sources:

- Upstream program lighting end-users
- Upstream program lighting distributors
- Downstream program participants
- Downstream influential design professionals and contractors.

The evaluation team also conducted interviews with key program administrator stakeholders from United Illuminating (UI) (6/21/2018) and Eversource (6/22/2018). The purpose of these interviews was to develop a thorough understanding of the programs being evaluated and priorities for the NTG evaluation, as well as to obtain clarifications and insights regarding program goals, implementation, and available program tracking data. We used findings from these interviews to inform the final sample design described below as well as survey and interview guide development.

The following sections detail the methodologies chronologically and by task. Relevant tasks include (1) Sample Design; (2) Survey and Interview Guide Development; (3) Data Collection; and (4) Analysis.

2.1 Sample Design

The objective of this task was to create a final sample frame to inform data collection and analysis. To develop the sample, the evaluation team reviewed program tracking data from both Eversource and United Illuminating in order to determine measure categories of interest and develop a preliminary sample design. Where possible and appropriate, the evaluation team tried to use categories from the previous NTG evaluation and the PSD. Table 2-1 below shows the steps the evaluation team took to prepare the data for analysis.

[10] Tetra Tech (February, 2015). National Grid, NSTAR, Western Massachusetts Electric Company, Unitil, and Cape Light Compact – 2013 Commercial and Industrial Electric Programs Free-ridership and Spillover Study.
[11] DNV GL, NMR Group, Tetra Tech (September 2018). Massachusetts Commercial and Industrial Upstream HVAC/Heat Pump and Hot Water NTG and Market Effects Indicator Study.

Table 2-1. Data Preparation Steps

Data Preparation Step	Number of Observations*		
	UI	Eversource	Total
Removed duplicate observations from the Eversource 2016/2017 and United Illuminating datasets.	2,092	6,085	8,177
Aggregated equipment-level Eversource customer data by end-use for both 2016 and 2017.	2,092	4,933	7,025
Merged the combined Eversource data to the United Illuminating data together.	2,092	4,933	7,025
Reviewed the final combined datafile for consistency by creating QC tables of each separate dataset's savings values and installed measure quantities in order to ensure all data from each dataset were present.	2,092	4,933	7,025
Removed administrative adjustment, comprehensive, and incentive measures with no savings associated*	1,253	4,478	5,731

**Number of observations are presented at the measure level.*
**The "administrative adjustment" measure refers to a measure that does not have associated savings, but was used to make an edit to a previous project incentive. "Comprehensive" refers to an incentive, and also does not have savings associated.*

Once the data were prepared, the evaluation team stratified the sample based on measure category and measure savings, as described below. Within each measure category stratum, we included sufficient samples to estimate a NTG ratio with an 80/20 or 80/10 confidence and precision level. At the program level, we included sufficient samples to estimate a NTG ratio with a 90/5 confidence and precision level for electric measures and a 90/10 confidence and precision level for gas measures. These targets were set balancing industry standards in NTG research with available resources for this study, while still supporting calculation of NTG estimates at the measure category level. See Table 2-4 below for details.

The sample design was developed at the project level and is based on a prioritization of measure categories. Each measure was assigned to one of nine measure groups for electric measures (plus a separate stratum for upstream lighting) and one of five measure groups for gas measures. Tables that display each measure category and the measure descriptions contained within it for electric and natural gas measures are shown in Appendix E and summarized in Table 2-2 and Table 2-3 below.

Table 2-2. Electric Measure Descriptions

Measure Category	Measure Description
Controls	EMS - Cooling
	EMS - Heating
	Energy Management System (EMS)
Cooling	CNI Custom Cooling
	Dehumidification

Measure Category	Measure Description
	Dual Enthalpy Economizer
	Envelop-Glazing
	Envelope-Insulation
	VFD on Chilled Water Pump
Custom	CNI Custom Other
	Custom, Custom
Heating	CNI Custom Heating
	CNI Custom HVAC
	Heating, Custom
	VFD on Hot Water Pump
Lighting	Advanced Lighting Control
	Daylighting Control
	Enhanced - Aggregated Network LED controls
	Exterior Lighting
	High Perf - Aggregated LED with Controls
	Interior Lighting
	Lighting Rebate
	Lighting, Express Service
	Occ Sensor - Room
	Refrigeration Case Lighting
	Standard - Aggregated Lighting measure
	Standard - Exterior Lighting
	Standard - Interior Lighting
	TLED - Exterior Lighting
	TLED - Interior Lighting
Motor	CNI Custom Motor
	EC Motor or Fan
Other	Kitchen Hood Control
	Variable Frequency Drives
Process	CNI Custom Process
	Custom Process
	Process, Custom
Refrigeration	Door Heater Control – Refrigeration
	EC Motor - Refrigeration
	Floating Head Pressure Control
	Night Covers - Refrigeration
	Vending Miser - Refrigeration

Table 2-3. Natural Gas Measure Descriptions

Measure Category	Measure Description
Controls	EMS - Heating
	EMS - Heating and Cooling
	Energy Management Systems (EMS)
Custom	CNI Custom Other
	Custom, Custom
	HVAC, Custom
Domestic Hot Water	CNI Custom Domestic Hot Water
	DHW, Custom
Heating	CNI Custom Heating
	Energy Recovery from Exhaust Air - Heating
	Heat Recovery from Process
	Heating, Custom
	Weatherization - Heating
Other	Kitchen Hood Control
Process	CNI Custom Process
	Process, Custom

Our sample design reviewed and accounted for both (1) projects that included multiple measures and (2) customer representatives that were involved in multiple projects. First, as part of our analysis, we reviewed projects that included multiple measures and prioritized measures that were under-represented in the program portfolio to ensure representation. Using this method, we selected up to two measures for each project (selecting *more* than two measures would likely have increased respondent fatigue and impacted the quality of the data). Second, our team flagged customers that were involved in more than one project (e.g., one customer completed five unique lighting projects). For these projects, an experienced qualitative researcher at the evaluation team administered the NTG battery in order to assess similarities across projects and then ask further probing questions to explore the decision-making process. The Blackstone Group conducted the remaining single project interviews that consisted of just one contact per project.

It should be noted that the evaluation team first developed a sample that described savings at the end-use measure level. Prior to data collection, we aggregated the data to the project level to conduct the downstream participant survey and re-calculated the sample targets using the new aggregated data. The revised sample design represents the same number of measures and overall savings as the original design, but with data that has been re-arranged to be at the project level, effectively collapsing multiple measures within the same end-use category (e.g., multiple types of lighting equipment aggregated to lighting) up to the overall project. Table 2-4 and Table 2-5 below detail the additional aggregation step to the population by electric and gas end-use categories, and present the proposed and revised sample sizes. Population in each table is shown first at the measure level, then at the project level. The measure level details the rows of each measure included in the original merged dataset. The project level represents the collapsed measure level data that has been aggregated up to be unique at the project level. These data represent the same level of savings at both the measure and project level. The "total" row represents the savings for the total number of projects in the population.

Table 2-4. Final Energy Opportunities Program NTG Sample Design (Electric)

Sample Stratum	Population (Measure Level)	Population (Project Level)	Total Measure Savings (kWh)	Confidence	Precision	Project Level Sample Size (Final)
Controls	52	43	2,947,223	80	20	8
Cooling	215	153	12,980,074	80	10	27
Custom	149	89	5,316,081	80	10	22
Heating	63	39	1,885,558	80	20	7
Lighting	4,380	2,851	254,580,178	90	10	67
Motor	91	75	7,220,257	80	20	9
Other	14	9	347,383	80	20	4
Process	94	66	12,424,185	80	10	19
Refrigeration	166	120	12,092,573	80	10	19
Upstream Lighting	507	NA	2,483,565	84	16	12
Total	**5,731**	**3,445**	**312,277,077**	**90**	**5**	**194**

Table 2-5. Final Energy Opportunities Program NTG Sample Design (Gas)

Sample Stratum	Population (Measure Level)	Population (Project Level)	Total Savings (CCF)	Confidence	Precision	Project Level Sample Size (Final)
Controls	53	35	250,632	80	10	13
Custom	40	23	562,936	80	10	10
Heating/DHW	226	136	1,578,666	80	10	26
Other	8	3	49,081	80	10	2
Process	49	29	1,586,902	80	10	11
Total	**376**	**226**	**4,028,217**	**90**	**5**	**62**

Final free-ridership and spillover rates were then weighted by measure kWh or CCF savings to account for any disproportional sampling due to stratification. By weighting our results, we ensure that the NTG ratio estimates are representative of the program population while still reflecting differences between measures. Weighting tables to explain this process can be found in Appendix F.

2.2 Interview Guide Development

This section describes the detailed approach to NTG instrument development. These instruments include:

- Downstream program participant interviews
- Influential design professional interviews
- Upstream lighting end-user interviews
- Upstream lighting distributor interviews

Table 2-6 presents a mapping of data sources to the various components of the NTG calculation. As a note, upstream free-rider and spillover data were attainable only for Eversource, since, at the time of sample development, the United Illuminating upstream program data files did not contain contact data (e.g., contact name, telephone number, email address) for participants and contained values of "1" for all sales quantities, which could not be used to populate the fields of the survey.

Table 2-6. Free-ridership and Spillover Assessments by Data Source

Survey / Data Source	Free-ridership		Spillover	
	Downstream	Upstream	Downstream	Upstream
End-users	Yes	Yes (Eversource only)	Yes	Yes (Eversource only)
Trade-allies	Yes (If end-users report TA influence > 6)	No	No	No
Distributors	No	Yes (Qualitative)	No	Yes (Qualitative)

Downstream Program Participant Survey

The evaluation team used the survey instruments presented as part of the standard methodology developed in 2010 and 2011 for Massachusetts PAs as a starting point for the downstream survey development. While the standardized methodology served as a useful starting point for developing the survey, the evaluation team did make changes to improve respondent recall, increase consistency of responses, and provide a more complete "story" surrounding the participation decision. Most notably, for respondents who had completed multiple Energy Opportunities projects, we added an initial question asking respondents to describe, in their own words, the overall decision and equipment selection process: how the idea behind the project originated, what factors drove the design and equipment selection process and how the project was brought to completion. This question helped elicit more accurate responses and frame a more credible attribution narrative. In addition, this helped surveyors better frame question batteries that address the influence of technical assistance, incentives, project review, financing or other aspects of the program that are specifically designed to encourage the incremental improvements to energy efficiency embodied in the project.

Respondent bias is a second consideration that influenced survey development. Participants might understate the influence of the program because they want to show that they would have made the socially desirable energy-efficient decision, regardless of a rebate; or they might tend to overstate the influence of the program to ensure that it continues to provide funding or other assistance (the latter is particularly true for trade allies who use the availability of program rebates as a marketing tool). The evaluation team looked for inconsistencies in responses to questions regarding the influence of various program elements and the likelihood of the customer having taken the same action in the absence of the program. When they arose (e.g., a high likelihood of having undertaken a program-qualifying action regardless of the incentive, combined with a high rating for the influence of a program incentive on the purchase decision), we asked respondents to clarify. Such checking was programmed into a CATI script to trigger a consistency question when two contradictory responses were offered. The analysis methods for the downstream participant survey are covered in more detail in Section 2.4.

Influential Design Professional Interviews

When customer survey response indicated a high degree of design professional influence, the evaluation team used interviews with participating design professionals to assess both their influence on customers' purchase decisions and the program's influence on their sales practices. Following the 2011 standardized methodology, the influential design professional survey is triggered if a respondent reports a significant "outside" influence on their decision to implement the energy efficiency project. "Outside" influences are defined as either a third-party design professional, third-party engineer, contractor, or manufacturer's representative.

Significant influence is defined as a rating of a 7 or higher on a 0 ("no influence") to 10 ("a great deal of influence") scale. Using this methodology, 12 such interviews were triggered out of 20 survey respondents who identified a third-party design professional or vendor responsible for recommending their participation in the program. Of the seven design professionals who agreed to a further interview, six identified themselves as influential enough in project design and completed the full follow-up question battery.

Upstream Lighting End-User Interviews

The evaluation team developed the distributor interview guide questions by following the template of the interview guide developed for the Massachusetts Program Administrators and Advisory Council in 2018. [12] To estimate NTG ratios for upstream lighting projects with non-residential customers, the evaluation team conducted structured interviews with 12 participants in the Eversource upstream lighting program component to assess the impact of upstream program assistance on purchase decisions.[13] Estimates for the NTG for the upstream element of the program followed the 2018 methodology to the extent that the program data allowed and

[12] DNV-GL (July 2018). Massachusetts Program Administrators and Energy Efficiency Council. Massachusetts C&I Upstream Lighting Net-to-Gross Study - Draft Report.
[13] Given limited evaluation budget and the relatively small impact the upstream lighting program had on the 2016/2017 EO Program, we limited the number of interviews with end-users.

addressed both free-ridership and participant spillover. The analysis methods for the upstream lighting interviews are covered in more detail in Section 2.4.

Upstream Lighting Distributor Interviews

In addition, the evaluation team conducted interviews with four of the six distributors participating in the upstream program to estimate free-ridership and to obtain a qualitative indication of spillover associated with the upstream program. The evaluation team developed the distributor interview guide questions by following the template from the 2015 supplier self-report methodology conducted in Massachusetts in 2015.[14] We interviewed distributors to determine: (a) the extent of program-qualifying A-line LED and tubular/linear LED fixture sales outside of the upstream program, and (b) the extent to which the Connecticut programs influenced the sale of these program-qualified measures that were not subject to the program buydown.

2.3 Data Collection

The following section summarizes the evaluation team's data collection process for each of the four data collection instruments:

- Downstream program participant interviews and upstream lighting end-user interviews
- Influential design professional interviews
- Upstream lighting distributor interviews.

Disposition reports are included for each survey below.

Downstream Participant Survey and Upstream Lighting End-User Interviews

The evaluation team employed the Blackstone Group to collect data for the participant NTG survey via a CATI telephone survey. The evaluation team ensured that the interviewers were familiar with the complex logic associated with the methodology and received test data for five interviewees before moving forward with a hard launch of the survey. The evaluation team used customer account representatives as outreach liaisons in cases where certain projects were deemed to be critical to the validity of the study (e.g., large project numbers for a single contact). In addition, the evaluation team drafted and sent advance letters on utility letterhead (including a summary of study intent, and estimated participation time) to program participants and trade allies to increase responses rates.

While Blackstone Group spoke with program participants who participated in smaller-scale, usually single projects, the evaluation team spoke with larger vendors and participants from more complex projects via an in-depth telephone interview. The evaluation team used a

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[14] Cadmus (March 2015). Massachusetts Upstream Lighting Program Net-to-Gross Ratio Estimates Using Supplier Self-Report Methodology. Appendix B, *Interview Guide for Manufacturers and Retail Buyers Participating in the 2013 Massachusetts and Connecticut ENERGY STAR® Lighting Programs.*

modified version of the survey instrument to interview these participants. With this survey, these participants were asked about multiple projects and measure categories and were to describe important differences between projects. This information was used to determine whether the responses provided could be further extrapolated to all projects these participants completed.

Fielding for the downstream participant survey took place between November 15th, 2018 and May 1st, 2019. Once calling began, the evaluation team noted a large number of inactive phone numbers or contacts with either a 1-800 number listed or with contact information that was no longer valid or relevant. In order to increase response rates for these participants, the evaluation team requested help from utility program staff to provide updated contact information for a select number of designated priority survey participants with inactive or inaccurate contact information. The incentive was also increased from $25 to $100 in February of 2019 in a further attempt to increase response rates. Table 2-7 (electric) and Table 2-8 (gas) below present dispositions by end-use level in greater detail. While traditional response rate calculations are not applicable given the interview design, the evaluation team achieved a 15% response (completing 110 interviews with 721 unique project representatives).

The evaluation team conducted interviews with upstream lighting participants and downstream program participants simultaneously. Interviews with upstream lighting end-users were conducted between December 2018 and January 2019. A $25 incentive was provided to all end-users who participated in the survey. Detailed dispositions for the upstream lighting end-user interviews are also listed below in Table 2-7.

Table 2-7. Participant Interview Final Dispositions (Electric Projects)

Sample Stratum	Utility	Population	Sample Frame	Refused	Bad Contacts	Target	Completed	Number of Unique Interviews*
Controls	Eversource	23	23	2	5	8	3	3
	UI	20	20	1	2		3	2
Cooling	Eversource	147	147	15	24	27	50	8
	UI	6	6	3	0		2	1
Custom	Eversource	49	49	6	4	22	3	4
	UI	40	40	5	7		19	5
Heating	Eversource	27	27	4	8	7	5	3
	UI	12	12	2	2		0	0
Lighting	Eversource	2,346	575	14	67	67	124	12
	UI	505	212	4	21		53	10
Motor	Eversource	75	75	11	18	9	20	8
	UI	0	0	0	0		0	0
Other	Eversource	2	2	0	2	4	0	0
	UI	8	8	2	0		5	4
Process	Eversource	53	53	6	12	19	17	8
	UI	13	13	0	8		3	3
Refrigeration	Eversource	100	100	3	11	19	71	3
	UI	20	20	2	1		5	1
Upstream Lighting	Eversource	507	97	0	7	12	12	12
Total		3,953	1,382	80	199	194	395	87

**Note that the total number of interviews by end-use is greater than the total distinct number of interviews, because the majority of respondents were interviewed for two end-use categories.*

Table 2-8. Participant Survey Final Dispositions (Gas)

Sample Stratum	Utility	Population	Sample Frame	Refused	Bad Contacts or Ineligible	Target	Completed	Number of Unique Interviews*
Controls	Eversource	15	15	0	3	13	6	1
	UI	20	20	0	5		11	3
Custom	Eversource	2	2	0	0	10	1	1
	UI	21	21	0	0		10	2
Heating/DHW	Eversource	96	96	10	36	26	22	8
	UI	40	40	4	6		9	4
Other	Eversource	1	1	0	0	2	0	0
	UI	2	2	0	1		1	1
Process	Eversource	20	20	2	2	11	6	2
	UI	9	9	1	4		4	1
Total		226	226	17	57	62	70	23

**Note that the total number of interviews by end-users is greater than the total distinct number of interviews, because the majority of respondents were interviewed for two end-use categories.*

Table 2-7 below presents the above information as population savings compared to sampled savings by fuel type and end-use.

Table 2-9. Population and Sampled Savings by Fuel Type and End-use

End-Use	Fuel Type	Population Savings (kWh)	Sampled Savings (kWh)
Controls	Electric	2,947,223	1,543,016
Cooling	Electric	12,980,074	4,009,364
Custom	Electric	5,316,081	1,965,339
Heating	Electric	1,885,558	182,644
Lighting	Electric	254,580,178	31,713,569
Motor	Electric	7,220,257	650,885
Other	Electric	347,383	95,393
Process	Electric	12,424,185	3,785,907
Refrigeration	Electric	12,092,573	9,938,868
Upstream lighting	Electric	2,483,565	159,434
Overall Electric		**312,277,077**	**54,044,421**
		Population Savings (CCF)	Sampled Savings (CCF)
Controls	Gas	250,632	73,647
Custom	Gas	562,936	153,383
Heating / DHW	Gas	1,578,666	239,542
Other	Gas	49,081	5,015
Process	Gas	1,586,902	460,417
Overall Gas		**4,028,218**	**932,004**

Downstream Influential Design Professional and Vendor Survey

Once the evaluation team completed conducting interviews for the downstream survey, the evaluation team identified 12 survey participants who indicated that a contractor or design professional (i.e., vendor) had a significant influence on their decision to install the particular set of equipment that was incented by the program. In most cases, these survey participants had also provided the name and phone numbers of the design professional or vendor that they deemed influential. For participants who were only able to provide a name or business, the evaluation team conducted background research to determine the appropriate business to call. Fielding for the influential design professional and vendor survey took place between May 1st, 2019 and May 22nd, 2019. No incentives were provided for influential design professionals or vendors who participated in the survey. Detailed dispositions for the 12 influential vendors are reported in Table 2-10 below.

Table 2-10. Downstream Influential Design Professional and Vendor Survey Final Dispositions

Status	Sample Points
Original Sample	12
Total contacted	12
No Working Number	0
Adjusted Sample	12
Refusal	2
Unreachable	3
Completed Interviews	7
Cooperation Rate	58%

Upstream Lighting Distributor Survey

Similarly to the upstream lighting end-users, interviews with upstream lighting distributors who participated in the upstream lighting program were conducted between December 2018 and January 2019. A $25 incentive was provided to all distributors who participated in the survey. Detailed dispositions for the upstream lighting distributors are listed below in Table 2-11.

Table 2-11. Final Upstream Lighting Distributor Dispositions

Status	Sample Points
Original Sample	6
Total contacted	6
Refusal	2
Completed Interviews	4
Cooperation Rate	67%

2.4 Survey Analysis Methods

This section discusses the methods the evaluation team applied to analyze both the downstream and upstream participant program results. Below, we provide a detailed explanation of how we determined free-ridership, spillover, and the NTG ratio for both the upstream and downstream analyses.

Downstream Analysis Methods

The evaluation team used the standardized Massachusetts methodology for analysis of downstream survey results.[15] Our analysis included the estimation of three program influence scores: free-ridership, like-spillover, and unlike-spillover. The generalized equation we used to compute the final NTG ratios for the EO program is shown below in Equation 2-1.

Equation 2-1. Downstream Participant Net-to-Gross Ratios (NTGRs) Equation

$$NTG = 1 - Free\ Ridership\ +\ Like\ Spillover + Unlike\ Spillover$$

Note that this evaluation does not include an estimate of non-participant spillover as was included in past NTG research in Connecticut. The evaluation team did not include non-participant spillover in our approach, instead prioritizing evaluation dollars on increased sample sizes across end-uses. Notably, the 2011 Connecticut NTG study did not find any evidence of non-participant spillover and as a result, the absence of this estimate here aligns with past trends and we recommend no further adjustment. Similarly, the 2011 NTG study did find qualitative evidence of unlike spillover; as a result, we attempted to quantify it as part of this study. We provide greater details below.

Free-Ridership Rate Analysis

As noted in the introduction, the evaluation team defines a *free-rider* as a program participant who received an incentive or other assistance though an energy efficiency program who would have installed the same high-efficiency measure type on their own and at the same time had the program not been offered. A program's *free-ridership rate* is therefore the percentage of program savings attributed to free-riders. For a participant to be considered a pure or 100% free-rider, it is assumed that the program had zero direct or indirect influence on their decision to install an energy-efficient measure type. As a result of this, none of the energy savings from the energy-efficient measure installed should be attributable to the success of the program.

Our analysis also identifies the extent of free-ridership for each customer. A participant is considered a *pure free-rider* (100% free-ridership rate) if the customer would have purchased and installed the equipment in less than six months, would have purchased the exact same amount of equipment, would have purchased a similar efficiency level as what they installed through the program, and would have paid for the entire measure cost. Conversely, we assume that the program fully influenced a respondent's decision to purchase and install energy efficient equipment if they indicated they would not have purchased the energy-efficient equipment at all without support, or would have purchased the equipment more than two years later. These respondents were assigned an overall free-ridership rate of 0%.

If the customer is neither a pure free-rider nor a fully-influenced program participant, they are assigned a partial free-ridership (1-99%) rate. The partial free-ridership score is made of up three separate components: quantity, efficiency, and timing. If a respondent indicated that they would have installed some equipment in the absence of the program, surveyors asked the respondent to estimate:

- The quantity of equipment installed in the absence of the program (quantity score)

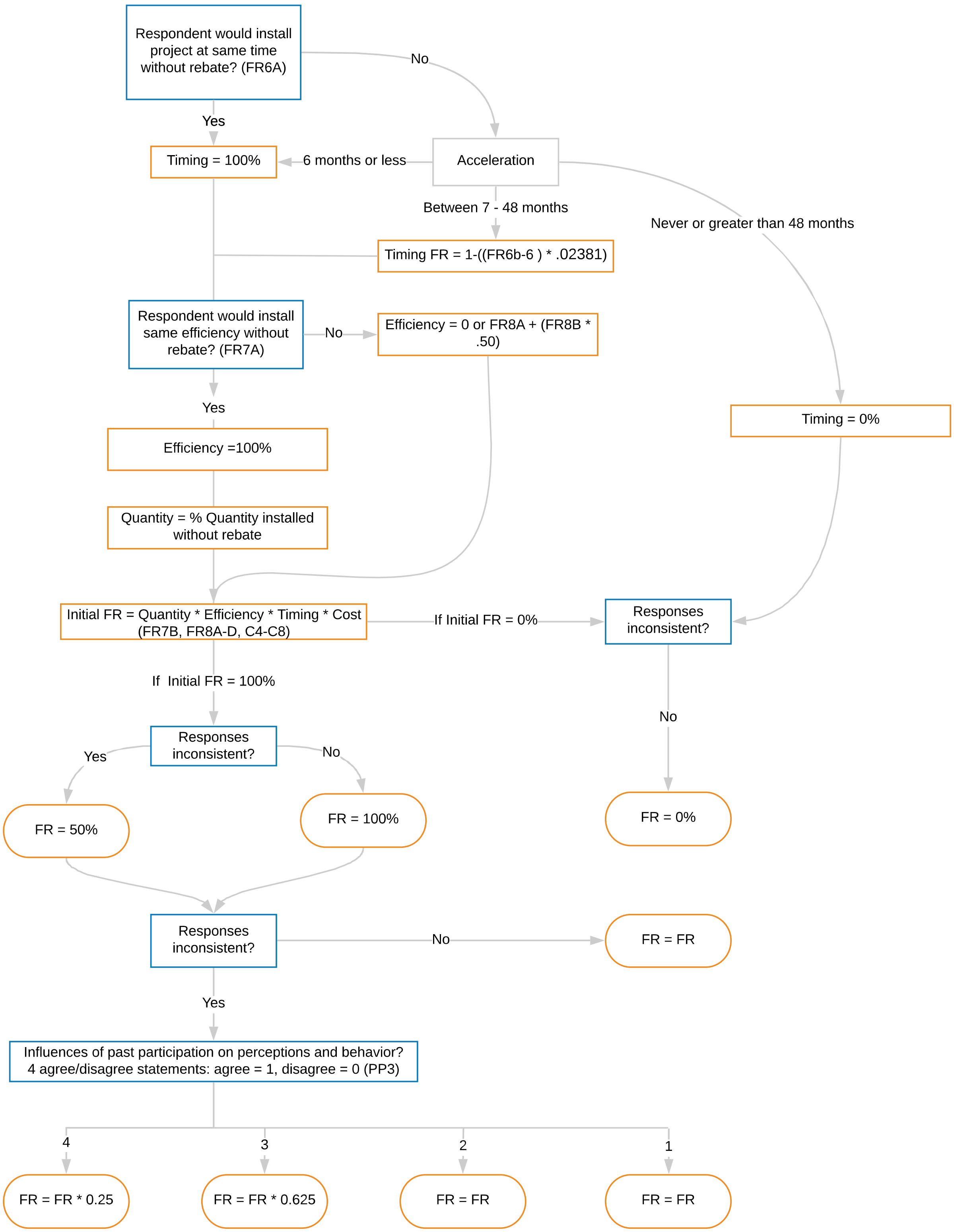
[15] Cross-Cutting Net to Gross Methodology Study for Residential Programs – Suggested Approaches (Final). Prepared for the Massachusetts Program Administrators. July 2011.

- The efficiency level of the equipment installed in the absence of the program (efficiency score)
- The timing of equipment installation in the absence of the program (timing factor)

The quantity score was calculated as the percentage of the incentivized equipment that would have been installed in the absence of the program. The efficiency score represents the percentage of savings per unit installed that would have occurred without the program. For equipment that is reported to be more efficient than standard but less efficient than what was installed through the program, we assume 50% of the savings for those measures. For equipment that was reported to be standard efficiency or code, we assume 100% of the savings for those measures.

Multiplying the quantity and efficiency scores yields the raw free-ridership estimate. A timing factor is applied to the raw free-ridership to adjust the estimate downward for savings that would have occurred without the program, but not until a much later date (to ensure the program is given credit for accelerating the installation of energy-efficient equipment). Once an initial free-ridership rate was developed, the evaluation team reviewed each estimate to ensure its consistency with other survey responses. Additional adjustments may have been applied, depending on previous program participation and influence by third-party vendors. The flow chart presented in Figure 2-1 shows the process used to estimate free-ridership results.

Figure 2-1. Downstream Free-Ridership Scoring Flowchart



In cases where respondents report an influential design professional to be highly influential in their selection of equipment, results of an influential design professional interview superseded the customer's responses (e.g., if the customer reports little direct program influence, but significant design professional influence, and the design professional interview finds that the seller was strongly influenced by the program). The logic for triggering the use of influential design professional interview data is shown Figure 2-2 below.

Figure 2-2. Influential Design Professional Interview Trigger Flowchart

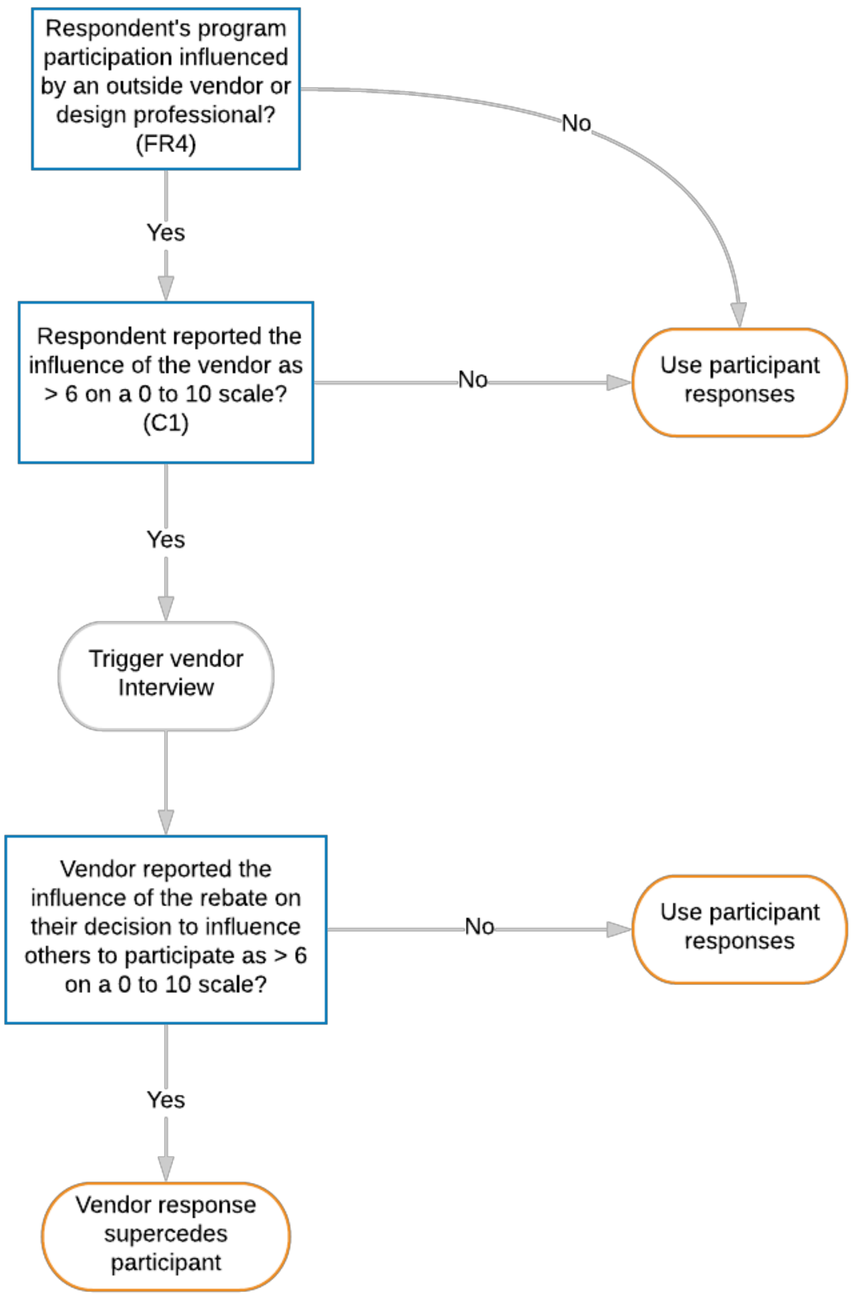
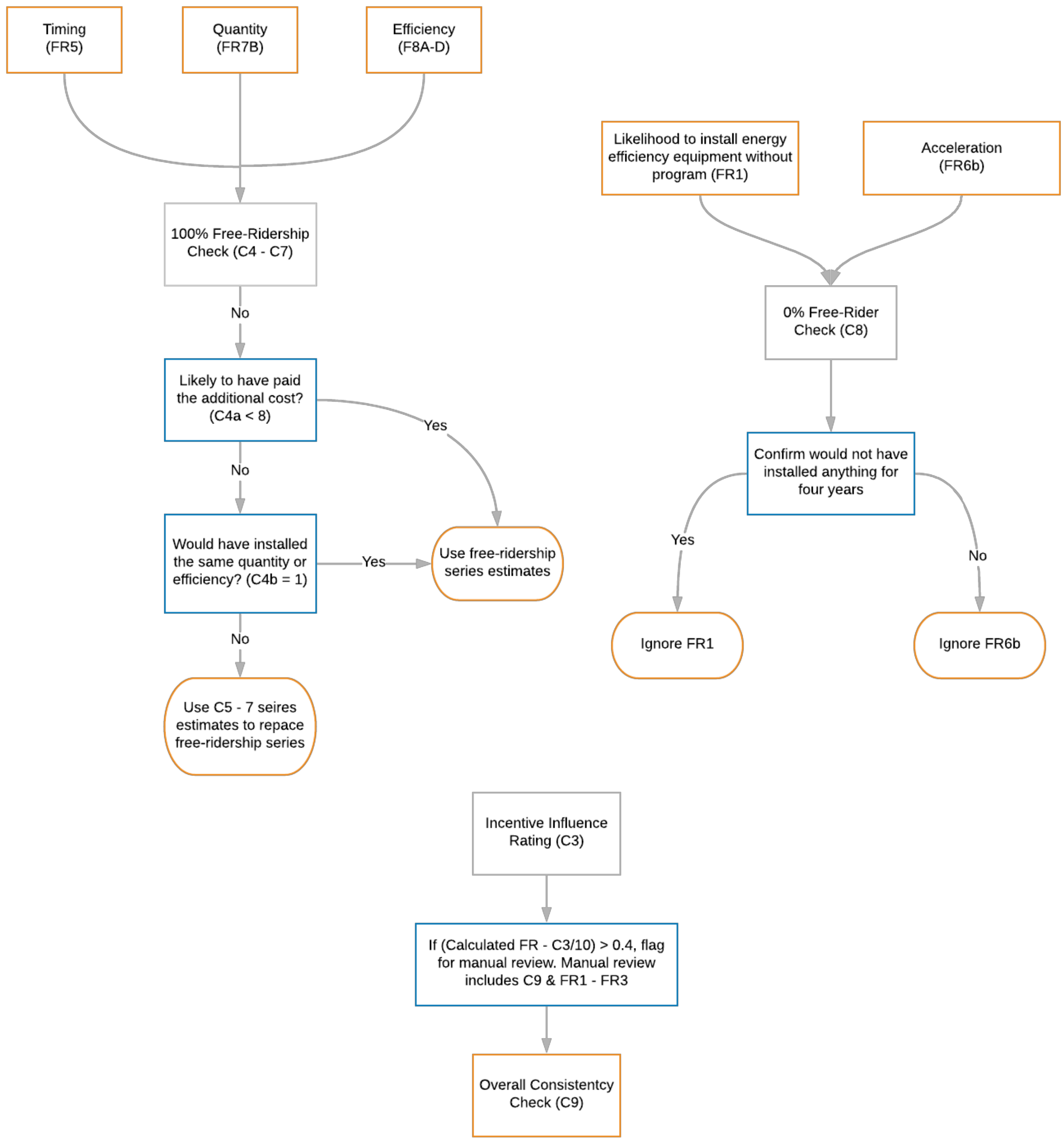


Figure 2-3 below displays the consistency checks applied to a participant's raw free-ridership score. Consistency checks were triggered if a survey respondent was identified as a pure free-rider (100%) or if the respondent was identified as a 0% free-rider. The free-ridership rate was then applied to the measure savings associated with their sampled project. The total free-ridership estimates in this report include pure, partial, and non-free-riders. Total free-ridership rates were then weighted by measure kWh or CCF savings to account for any disproportional sampling due to stratification. By weighting our results, we ensure that the NTG ratio estimates are representative of the program population while still reflecting differences between measures. Weighting tables to explain this process can be found in Appendix F.

Figure 2-3. Free-Ridership Consistency Checks



Spillover Rate Analysis

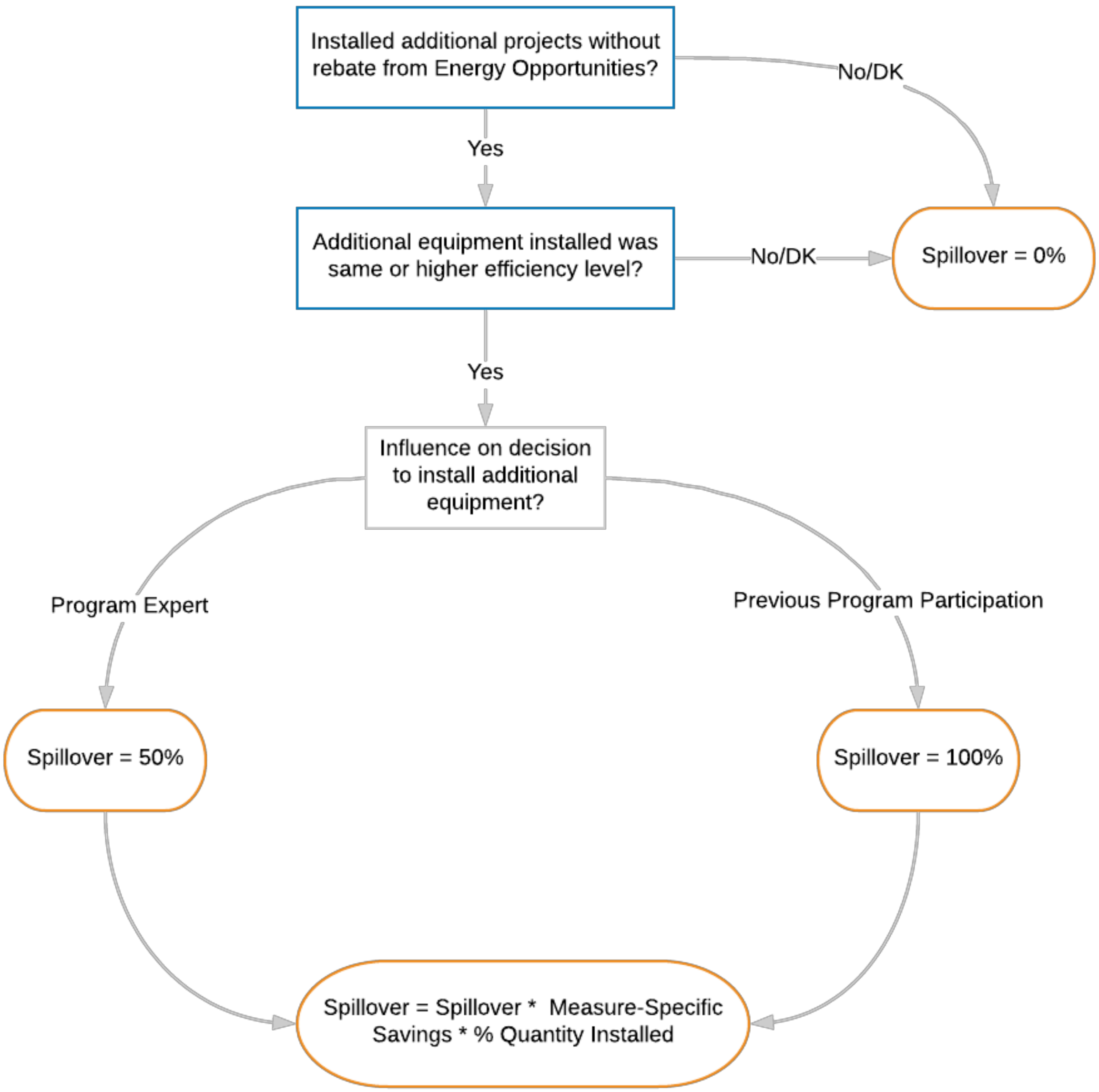
For downstream program participants, the evaluation team computed two forms of spillover: like and unlike-spillover. *Like-spillover* refers to situations where a customer installed energy efficiency measures through the program, and then installed additional measures of the same type due to program influences, but without receiving an incentive. *Unlike-spillover* refers to situations where the customer installs other types of energy-efficient measures outside of the program (i.e., they do not receive any incentives) but past experience with the EO program influenced them to do so.

The like-spillover estimates were computed based on how much more of the same energy-efficient equipment was installed outside the program with receiving an incentive, but that was influenced by the program. In the downstream survey, if a respondent reported that they installed energy-efficient equipment outside of a PA-sponsored program, they were asked to identify the efficiency level and the quantity of the equipment installed. If a respondent answered that they installed equipment of the same efficiency level or higher as the equipment installed through the program, spillover savings were calculated as the measure-specific savings identified in the program multiplied by the quantity of the equipment installed by the participant. If a participant identified that their energy-efficient equipment purchased was of lower efficiency than the equipment installed as part of the program but still more efficient than standard efficiency or code equipment, spillover savings were calculated as 50% of the measure-specific savings identified in the program by the quantity of the new equipment installed by the participant.

Furthermore, if the respondent identified that a recommendation from a vendor such as contractor, distributor, engineer, or designer influenced their decision to install like equipment on their own, we attributed the program with 50% of those savings based on the influence the program had on the trade allies. However, if general past program participation impacted their decision, then we attributed the program with 100% of the spillover savings.

Unlike-spillover rates were identified in a manner similar to like-spillover but, instead, program eligibility was used as a proxy for energy efficiency. To estimate savings for unlike spillover, we found the average per project savings for each end-use. If a respondent reported installing an additional project that matched the end-uses in our study, we were able to estimate these savings by multiplying the average savings by the quantity of equipment they reported. If a customer reported an end-use not within the scope of this study, we were unable to provide estimates for unlike-spillover. Similar to how like-spillover was calculated, if the respondent identified that a recommendation from a vendor—such as contractor, distributor, engineer, or designer—influenced their decision to install like equipment on their own, we attributed the program with 50% of those savings based on the influence the program had on the trade allies. However, if general past program participation impacted their decision, then we attributed the program with 100% of the spillover savings. Like and unlike-spillover savings estimates were then weighted by the measure kWh or CCF savings to account for contribution to the program and project size. The flowchart presented in Figure 2-4 provides more details on how the results of survey questions were used to determine the spillover rate.

Figure 2-4. Downstream Like & Un-like Spillover Flowchart



Calculation of Net-to-Gross Ratio

The evaluation team calculated free-ridership rates and spillover rates as ratios of the sampled 2016-2017 Energy Opportunities downstream program, characterized as free-ridership or spillover savings to totaled sampled savings. These calculations are shown in detail in Equation 2-2 and Equation 2-3. The weighted net free-ridership, net like-spillover, and net unlike-spillover estimates were then used to estimate the program's NTG ratio, following Equation 2-1 detailed above.

Equation 2-2. Net Free-Ridership Calculation

$$Net\ Free\ Ridership = \frac{\sum(Program\ Savings_i * Free\ Ridership\ Rate_i * Measure\ Weight_i)}{\sum(Program\ Savings_i * Measure\ Weight_i)}$$

Equation 2-3. Net Spillover Program Calculation

$$Net\ Spillover = \frac{\sum(Program\ Savings_i * Like\ Spillover\ Rate_i * Measure\ Weight_i)}{\sum(\ Program\ Savings_i * Measure\ Weight_i)} + \frac{\sum(Program\ Savings_i * Unlike\ Spillover\ Rate_i * Measure\ Weight_i)}{\sum(\ Program\ Savings_i * Measure\ Weight_i)}$$

Upstream Analysis Methods

The evaluation team conducted structured interviews with 12 participants in the Eversource upstream lighting program component to assess the impact of EO program assistance on purchasing decisions. Estimates for the upstream element of the program followed the methodology developed for the Massachusetts Program Administrators and Advisory Council in in 2018[16] to the extent that program data allowed and addressed both free-ridership and participant spillover. This methodology was fairly similar to the 2011 Massachusetts methodology used for the downstream participant survey, with some minor changes. In general, a common challenge with assessing program influence among upstream programs is that end-users are unaware of the assistance provided by the PA in decreasing the cost of the lighting or increasing access to it. In these circumstances, market-level analysis (or other types of modeling) must be employed to identify the impact of the program on sales.

However, for the 2016/2017 EO program, customers were made aware of the upstream incentives through point-of-sale rebates and instore messaging. While different than a traditional downstream purchasing decision, the evaluation team is still able to use self-report methods to estimate program influence. These methods are included in an appendix and are based on tested methodologies employed recently in Massachusetts for a similar program design. In addition, given this uncertainty, we corroborated our results with analysis from data collected from lighting distributors. These methods are outlined in the sections below.

The evaluation team also conducted interviews with four distributors participating in the upstream program. These interviews were conducted to obtain a qualitative indication of free-ridership and spillover and to supplement the information collected from end-users by providing additional insights and context from distributors.

[16] DNV-GL (July, 2018). Massachusetts Program Administrators and Energy Efficiency Council. Massachusetts C&I Upstream Lighting Net-to-Gross Study - Draft Report.

Free-Ridership Rate Analysis

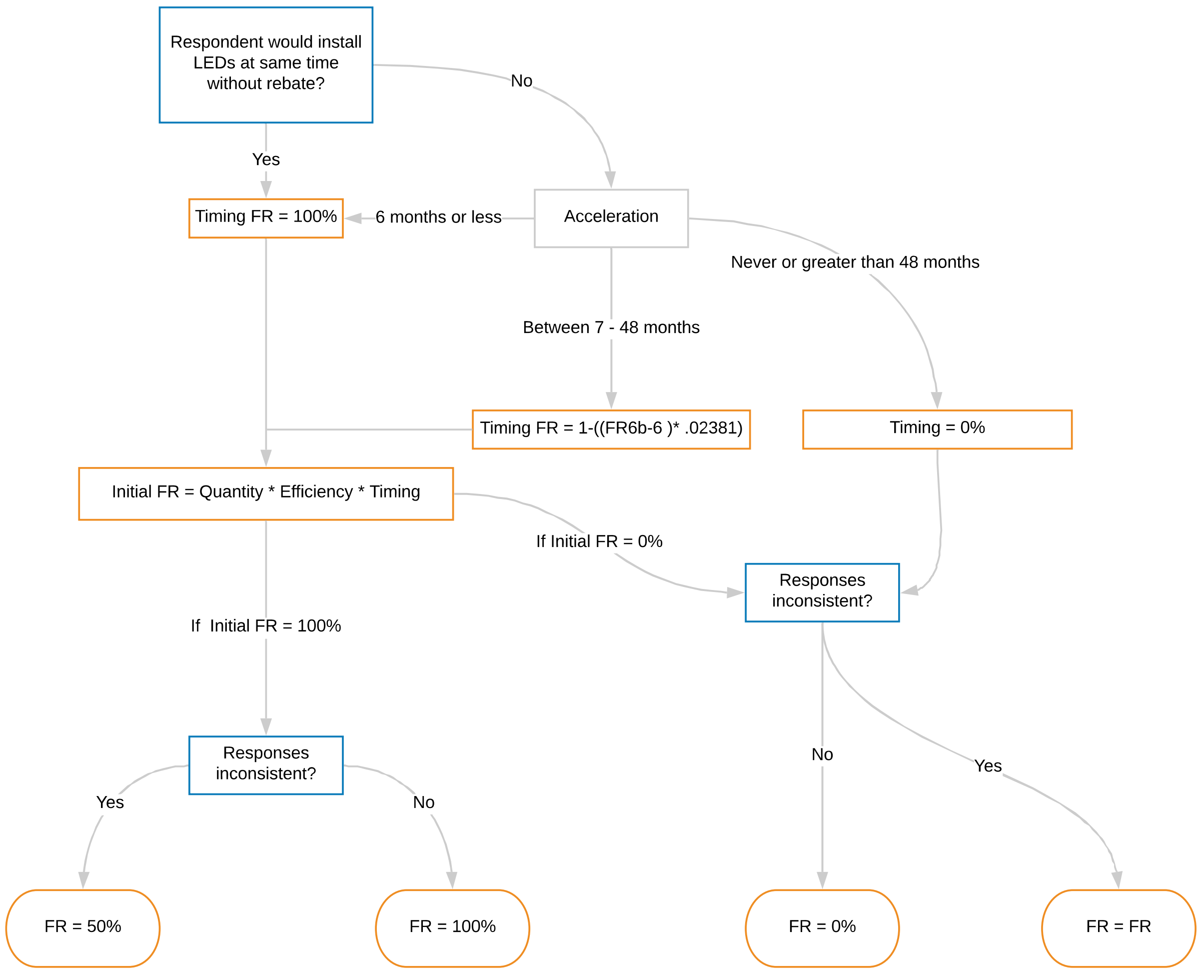
Sampled upstream lighting participants were asked a series of free-ridership questions. As the end-users who participated in the sample did not purchase any linear lighting fixtures, they were only asked questions regarding their screw-in bulb purchases. Much like the downstream survey, the upstream survey asked participants to assess the program's influence on the timing, quantity, and efficiency levels of their 2017 program purchases.

Survey participants were first asked if they would have purchased the LED lightbulbs at the same time, earlier, later, or never in the absence of the program. We considered a participant to be fully influenced (0% free-ridership) if they answered that they never would have purchased the LEDs without the program, if they would have purchased LEDs in the future but are unsure when, or if they would have purchased the LEDs more than two years later. If a participant indicated they would have purchased the same number of LEDs in less than six months, we considered them a pure free-rider (100% free-ridership). Similar to the downstream survey, if a participant was neither classified as a pure or non-free-rider, they were assigned a partial free-ridership score (1-99%). This partial free-ridership score is a function of the following:

- Timing of equipment purchase in the absence of the program
- Efficiency level of the equipment purchased in the absence of the program
- The quantity of LEDs purchased in the absence of the program

With regards to efficiency level, the evaluation team considers LEDs to be considered efficiency equipment, CFLs as lower efficiency lighting but still higher than code, and halogens as standard efficiency lighting. The initial free-ridership rate (i.e., timing x equipment x efficiency x quantity) was then subject to a consistency check by the evaluation team and adjusted accordingly if found inconsistent with other survey responses. Similar to the downstream survey, the free-ridership rates were also weighted by measure-level savings. Figure 2-5 below provides more detail on how the evaluation team calculated the initial free-ridership score.

Figure 2-5. Upstream Free-Ridership Scoring Flow-Chart



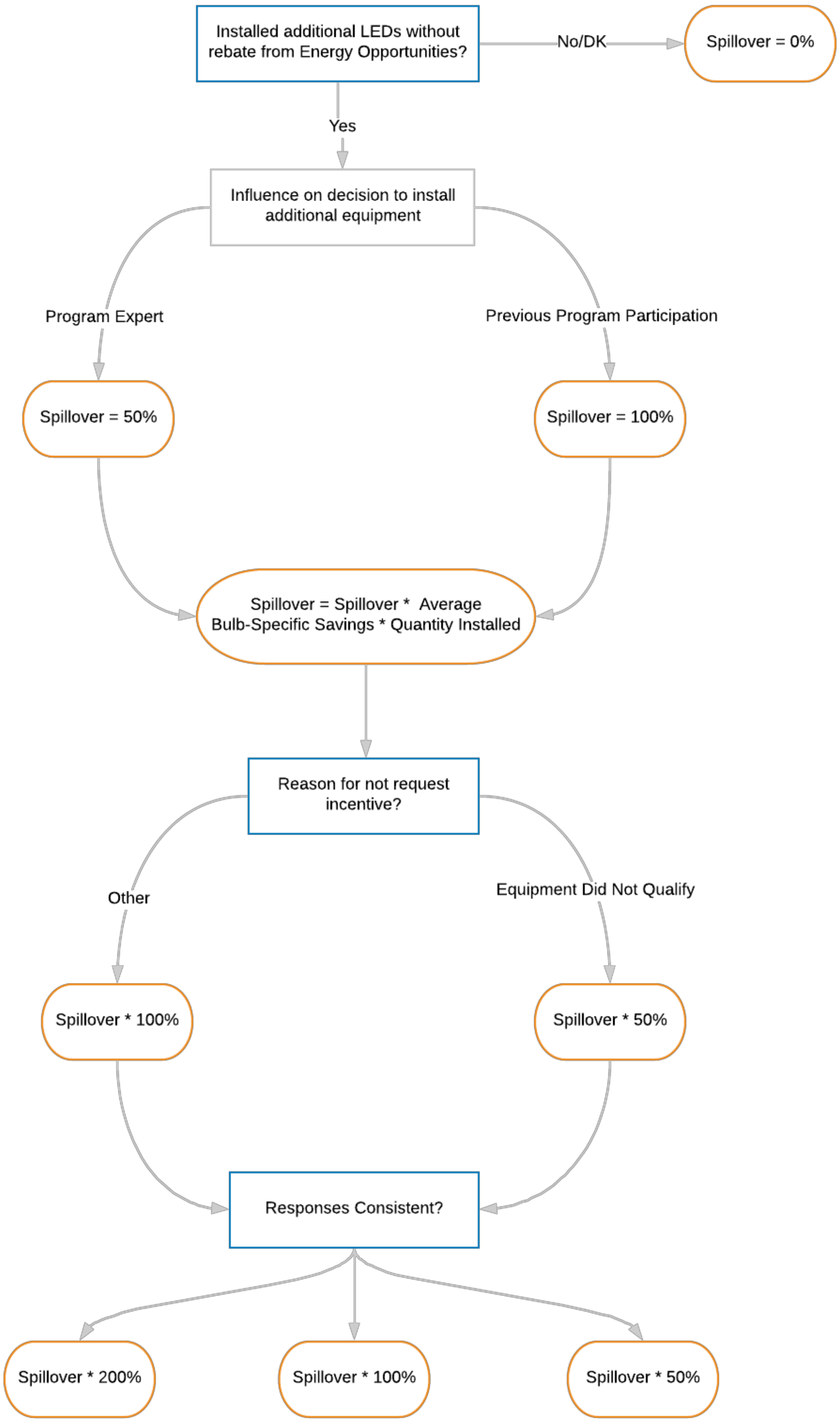
Spillover Rate Analysis

Similar to the downstream participant survey, upstream survey respondents were asked a series of questions related to spillover after the free-ridership section of the survey. The spillover questions are designed to assess whether a respondent's participation in any PA-sponsored program influenced their decision to purchase additional LEDs outside of the program. Respondents were first asked if they had purchased LEDs outside of a PA-sponsored program. If a respondent answered affirmatively, interviewers asked how many out-of-program LEDs were purchased. After assessing the quantity of out-of-program LEDs, surveyors then asked about influence of three program-related factors:

- Recommendations from third parties such as a contractor, distributor, engineer, or designer
- Past PA program participation
- LED program participation

If a participant noted they were influenced by a recommendation from a third party, they were assigned an initial spillover rate of 50%. If they were influenced instead by previous participation in a PA-sponsored program or an LED program, they were assigned an initial spillover rate of 100%. The evaluation team then conducted a consistency check and adjusted spillover rates if they were found to be inconsistent with other survey responses. If a respondent indicated in the survey that the program had more impact on their decision to purchase additional non-incented LED equipment than their spillover rate implies, their spillover rate was multiplied by 200%. Conversely, if a respondent indicated the program had less impact than what their spillover rate implies, their spillover rate was multiplied by 50%. Figure 2-6 below provides more information about how the evaluation team calculated spillover scores.

Figure 2-6. Upstream Spillover Scoring Chart



The spillover rate was then multiplied by the associated spillover savings with the project. Spillover savings were calculated using the self-reported out-of-program quantities reported during the survey, multiplied by the average savings for screw-in LEDs. We calculated the average savings by dividing the total savings for screw-in LEDs by the quantity of screw-in LEDs found in the tracking data.

Calculation of Net-to-Gross Ratio

Calculations for determining net free-ridership and net spillover are shown in detail in Equation 2-4 and Equation 2-5. The weighted net spillover savings and weighted net free-ridership savings estimates were then used to estimate the upstream lighting program's NTG ratio.

Equation 2-4. Net Free-Ridership Calculation

$$Net\ Free\ Ridership = \frac{\sum(Program\ Savings_i * Free\ Ridership\ Rate_i * Measure\ Weight_i)}{\sum(Program\ Savings_i * Measure\ Weight_i)}$$

Equation 2-5. Net Spillover Program Calculation

$$Net\ Spillover = \frac{\sum(Program\ Savings_i * Spillover\ Rate_i * Measure\ Weight_i)}{\sum(\ Program\ Savings_i * Measure\ Weight_i)}$$

3. RESULTS

The following chapter presents the results of the 2017 Energy Opportunities NTG study. First, we present results for the downstream program component. These results include:

- End-use level free-ridership rate estimates
- End-use level free-ridership component scores (timing, quantity, and efficiency)
- Consistency check adjustments
- Past participation adjustments
- End-use level like-spillover savings and rate estimates
- End-use level unlike-spillover savings and rate estimates

Second, we present results for the upstream program component. These results include:

- End-use level free-ridership rate estimates
- Free-ridership component scores (timing, quantity, and efficiency)
- Like-spillover estimates
- Supporting evidence from qualitative interviews with program distributors.

Finally, these results are compared to historic NTG ratios for the EO program as a benchmark for the scores developed in this study. A high-level summary of the program's NTG ratios by fuel type and end-use is included the following tables.

Table 3-1. NTG Study Results Fuel Type and End-Use - Electric

Sample Stratum Electric	Free-ridership	Like-spillover	Unlike Spillover	NTG Ratio	+/- Confidence Interval (90%)	+/- Confidence Interval (80%)
Controls	0.39	0.11	0.03	75%	N/A	35%
Cooling	0.12	0.05	0.00	93%	N/A	3%
Custom	0.23	0.00	0.00	77%	N/A	9%
Heating	0.14	0.07	0.00	93%	N/A	11%
Lighting	0.11	0.05	0.00	94%	4%	N/A
Motor	0.12	0.01	0.02	91%	N/A	6%
Other	0.00	0.00	0.00	100%	N/A	0%
Process	0.12	0.35	0.00	124%	N/A	7%
Refrigeration	0.13	0.00	0.00	88%	N/A	2%
Upstream Lighting	0.40	0.23	N/A	83%	N/A	14%
Overall Electric	0.12	0.06	0.003	94%	3%	**N/A**

Table 3-2. NTG Study Results Fuel Type and End-Use – Natural Gas

Sample Stratum Electric	Free-ridership	Like-spillover	Unlike Spillover	NTG Ratio	+/- Confidence Interval (90%)	+/- Confidence Interval (80%)
Controls	0.31	0.02	0.00	71%	N/A	28%
Custom	0.37	0.02	0.00	65%	N/A	12%
Heating / DHW	0.16	0.02	0.00	86%	N/A	5%
Other	0.00	0.00	0.00	100%	N/A	0%
Process	0.14	0.12	0.04	102%	N/A	13%
Overall Gas	0.19	0.06	0.02	89%	5%	**N/A**

3.1 Downstream Program Results

Free-Ridership Results

As part of the free-ridership battery of the downstream participant survey, the evaluation team asked survey respondents to estimate the timing, efficiency level, and quantity of equipment they would have installed in the absence of the program. These questions reference both the overall effect of the program (including staff recommendations and any technical assistance) and the specific effect of the financial incentive. The questions are listed below. Please note that these questions are measure-specific and are repeated for up to two measure categories.

FR5. If <PROGRAM ADMINISTRATOR> had not paid a portion of the implementation cost OR provided any technical assistance or education OR provided interest-free financing], would your business have implemented any type of <MEASURE> project at the same time?

1. Yes [SKIP TO FR7a]
2. No
D. DK
R. Refused

FR6a. Would you have implemented the <**MEASURE**> project earlier than you did, at a later date, or never?

1. Earlier
2. Same time [**REPEAT FR5**]
3. Later
4. Never [**SKIP TO END**]
D. Don't know [**SKIP TO END**]
R. Refused [**SKIP TO END**]

FR6b. How much [earlier / later] would you have implemented the <**MEASURE**> project?

___ YEARS
___ MONTHS
D. Don't know
R. Refused

[**IF QUANTITY IS NOT APPLICABLE FOR THIS MEASURE CATEGORY, SKIP TO FR8D**]

FR7a. Without the program incentive, technical assistance, or financing, would your business have implemented the <u>exact same quantity</u> of <**MEASURE**> project [**IF FR5 = YES or DK**: at that same time; **IF FR5=2**: within (**TIMEFRAME IN FR6b**)]?

1. Yes [**SKIP TO FR8**]
2. No
D. Don't know
R. Refused

[**IF FR7a = DK OR R, SKIP TO END**]

FR7b. Compared to the amount of <**MEASURE**> that you implemented through the program, what percent of the project do you think your business would have purchased on its own during that timeframe?

___ (**ENTER PERCENTAGE: 0-100%**)
D. Don't know
R. Refused

[**IF EFFICIENCY IS NOT APPLICABLE FOR THIS MEASURE CATEGORY SKIP TO END**]

[**IF QUANTITY IS GREATER THAN 1**]

FR8. You said your business would have installed [**IF FR7a = YES, FR8a - FR8c** ; **IF FR7a = NO: (FILL WITH FR7b PERCENT)]** of the equipment on its own if the program had not been available. **[ALL]** Thinking about the <**MEASURE**> equipment you would have installed on your own, what percent of this equipment would have been...?

a. of the same high efficiency as what was installed through the program?
___ (**ENTER PERCENTAGE 0-100%**)
D. Don't know

b. lower efficiency than what was purchased, but higher than standard efficiency or code?
___ (**ENTER PERCENTAGE 0-100%**)

D. Don't know

c. Standard efficiency or code
___ (**ENTER PERCENTAGE 0-100%**)
D. Don't know

[**IF QUANTITY IS LESS THAN 1**]

FR8d. Thinking about the <**MEASURE**> project you would have implemented on your own if the program had not been available, would it have been of the same high efficiency as what was installed through the program, lower efficiency than what was purchased but higher than standard efficiency, or standard efficiency or code?

1. Of the same high efficiency as what was installed through the program
2. Lower efficiency than what was purchased, but higher than standard efficiency
3. Standard efficiency or code
D. Don't know
R. Refused

The evaluation team scored each survey respondent's answers from these questions to determine their respective quantity and efficiency scores. The quantity score represents the percentage of the incentivized equipment that the respondent would have installed in the absence of the program. The efficiency score is the percentage of savings per unit installed that would have occurred without the program. For equipment reported to be more efficient than standard but less efficient than what was installed through the program, the evaluation team assumed 50% of the savings for those measures. The evaluation team then multiplied each respondents' quantity and efficiency scores together to yield their raw free-ridership rate.

The raw free-ridership score was then subject to a timing adjustment factor, as visualized in Figure 2-1. The timing factor adjusts the raw free-ridership estimate downward for all or part of the savings that would have occurred without the program, but not until much later. Multiplying a respondent's timing adjustment factor by the product of their quantity and efficiency score yields the adjusted free-ridership rate. Detailed calculations for the quantity, efficiency, and timing adjustment scores are shown in Table 3-3.

Table 3-3. Quantity, Efficiency, and Timing Score Calculations

Score	Response	Result
Quantity	Would have installed same quantity without program (FR7A = YES)	Quantity = 1
	Would have installed fewer quantity without program (FR7A = NO)	Quantity = FR7B
	Never would have installed (FR6A = never)	Quantity = 0
Efficiency	Would have installed the same level of energy efficient equipment on their own (FR8A)	Efficiency = 1
	Would have installed at least some energy efficient equipment on their own (FR8B)	Efficiency = FR8A + (FR8B * .50)
	Never would have installed (FR6A = never)	Efficiency = 0
Timing Adjustment	Would have installed at the same time without the program (FR5 = Yes)	Timing = 0
	Would have installed within six months of when participant actually did without the program (FR6b < 6 months)	Timing = 1
	Would have installed sometime between 7 and 48 months of when participant actually did without the program (FR6b > 6 months & < 48 months)	Timing = 1 – ((FR6b-6) * 0.2381)
	Would have installed sometime equal to or after 48 months of when participant actually did without the program (FR6b > 48 months)	Timing = 0
	Would have never installed without the program (FR6A = Never)	Timing = 0

Table 3-4 below presents the mean efficiency, quantity, and timing adjustment scores by end-use and fuel-type. Participants reported that the program accelerated their purchase and installation of the energy efficiency equipment (i.e., the Timing Adjustment Factor was overall lower than the Efficiency Score). However, without the program, participants reported that they would have purchased equipment that was of similar levels of efficiency (i.e., a relatively high Efficiency Score). However, these trends were offset by reported influence of past program participation, driving overall free-ridership down.

Table 3-4. Free-Ridership Component Scores

Sample Stratum	Fuel Type	Mean Quantity Score	Mean Efficiency Score	Mean Timing Adjustment Factor	Initial Total FR Score*
Controls	Electric	N/A	0.60	0.40	0.24
Cooling	Electric	0.26	0.87	0.91	0.79
Custom	Electric	0.37	0.46	0.71	0.33
Heating	Electric	N/A	0.63	0.57	0.36
Lighting	Electric	0.29	0.77	0.67	0.52
Motor	Electric	0.37	0.68	0.47	0.32
Other	Electric	N/A	1.00	0.00	0.00
Process	Electric	0.44	0.66	0.61	0.40
Refrigeration	Electric	0.67	0.98	0.99	0.97
Electric Overall		34%	74%	59%	44%
Controls	Gas	0.47	0.77	0.64	0.23
Custom	Gas	0.28	0.75	0.56	0.12
Heating / DHW	Gas	0.29	0.64	0.52	0.10
Other	Gas	N/A	0.50	0.00	0.00
Process	Gas	0.24	0.50	0.59	0.07
Gas Overall		32%	63%	46%	10%

**Note that this score includes adjustments from consistency checks and the past participation adjustment score.*

Respondents were also asked to describe in their own words what impact, if any, the assistance they received from the program had on their decision to implement or install energy-efficient equipment. These answers largely mirrored what was identified in the timing, quantity, and efficiency sections of the survey. A little more than half of respondents appeared to indicate that they still would have installed some equipment at the time that they did, but it would likely have been at a lower efficiency level or fewer in quantity. If a respondent was designated as a non-free-rider (0%) or pure free-rider (100%) and was found to contradict themselves in this open-ended section, their free-ridership score was adjusted to 50%. A sampling of responses from pure, non-, and partial free-riders is provided below in Table 3-5 below.

In addition, the free-ridership score was subject to an adjustment if a respondent indicated that they were influenced by previous program participation. Just 4% of respondents reported significant levels of influence from previous program participation, while 41% of respondents reported some level of influence from previous program participation. As outlined in Section 2.4, these respondents had their free-ridership scores reduced by 62.5% and 25%, respectively. Table 3-5 below demonstrates how consistency and past program participation adjustments affected the free-ridership scores by end-use.

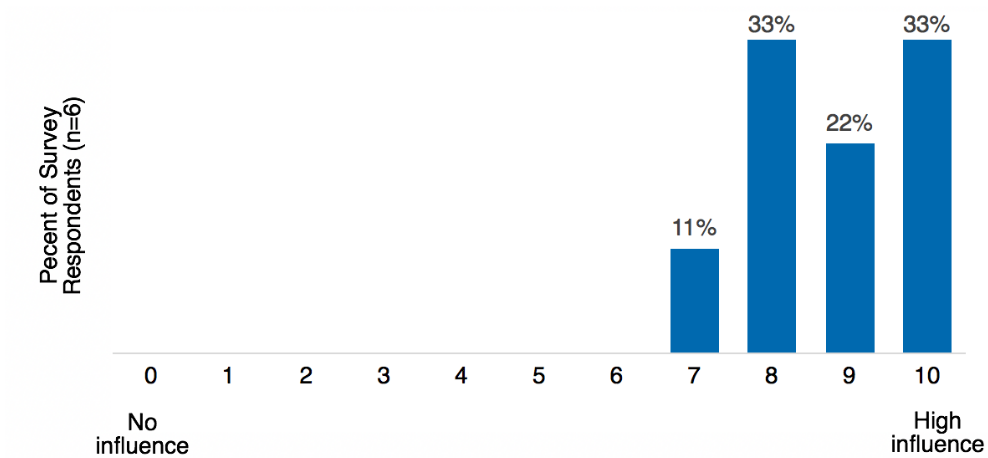
Table 3-5. Select Responses from Pure, Non-, and Partial Free-Riders

Type of Free-Rider	Response
Pure (100%)	"The only technical assistance we received was in the application process, other than that we didn't take assistance from the utility."
	"We had to [install the equipment] anyway."
	"Eversource had no impact. This was a small part of a much larger project."
Non- (0%)	"Like I said [the influence] is a hundred percent, without the assistance of UI, this project would not have gone forward."
	"I wouldn't have done any of it without their help. We're paying 1.5 million a month in energy at the plant. Whatever you can do to reduce it. Without them I wouldn't have been able to reduce it. Helping produce basic materials with less energy."
	"We would not have been in a financial position to ever implement a project if it had not been for Eversource."
	"100% impact. It's really that – the payback needed to be 2 or 2.5 years and this was 1.7 or 1.8 years."
Partial (1-99%)	"Basically, it gave us an avenue to fund projects making it more energy efficient to have more projects. We wouldn't have installed the same level of equipment if Eversource hadn't funded the project."
	"We still would have done the project, just less of it.
	"We would not have done the project at the time that we did without the funding from UI."

Next, if a respondent had indicated significant levels of program influence from a third-party design professional, vendor, or contractor, the evaluation team conducted individual interviews with the vendors identified by the survey respondent. The vendor was asked to indicate the program's influence on their decision to recommend the energy-efficient equipment to their client on a 0-to-10 scale, where 0 was no influence and 10 was highly influential. As shown in Figure 3-1 below which shows the percent of vendors that indicated each level of influence, all of the vendors interviewed for this study indicated significant levels of program influence in their decision to recommend equipment. These vendors were then asked a similar free-ridership battery, where they were asked if they would have recommended the same level of energy-efficient equipment at the same time. Their responses were given a timing, quantity, and efficiency score and also checked for consistency throughout the survey. As every vendor interviewed reported a high level of program influence, each instance where a participant reported being significantly influence by a vendor was replaced by the free-ridership estimate determined from the vendor survey. A selection of responses from vendors interviewed regarding the influence the program had in their customer's decision to participate in the program is included below.

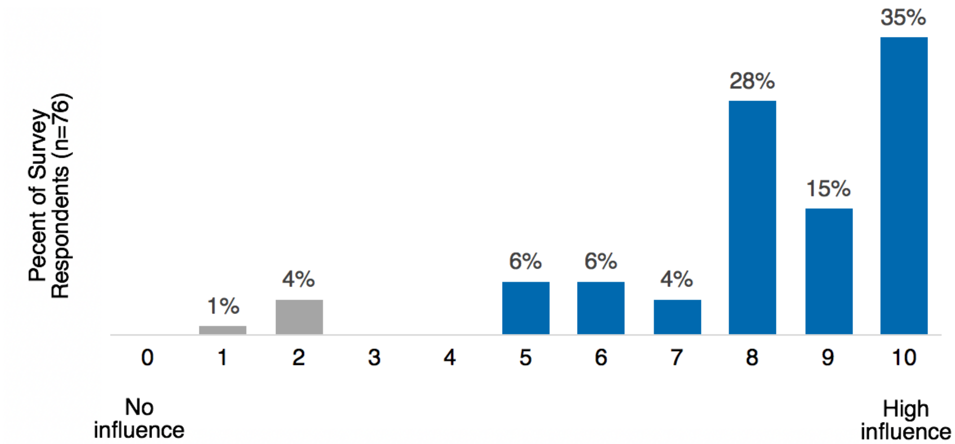
- "I think [the program] had a huge impact on their decision to do it… they were able to get the funding and make sure they put in something with high efficiency and a premium piece of equipment to upgrade the building [through the program] instead of just finding the cheapest equipment."
- "[The program] had everything to do with [their decision to install equipment]. The incentive they got helped to bring some urgency to the upgrade as opposed to putting it on a wish list but not getting to it."
- "[School districts] have distributed systems, few IT resources, and not a lot of money. The incentives are critical in our ability to sell the product to school districts and also to the districts' ability to purchase it. We lead the sale with power management, but also offer other features that IT people are happy with. The incentives bring down the ROI which helps convince the business people that it is a good idea to purchase the product."

Figure 3-1. Vendor-Reported Program Influence



Participants were also asked to rank the influence of the financial incentive they received from the program on a 0-to-10 scale, where 0 was no influence and 10 was high influence. These results also bolstered the results from the timing, efficiency, quantity, and open-end sections of the survey and suggest that respondents understand how the program influenced their decision-making process. As shown in Figure 3-2, 78% of survey respondents rated the program's influence on their decision to install energy efficient equipment as an 8 or higher. Just 5% of survey respondents ranked the program's influence as a 2 or lower.

Figure 3-2. Participant-Reported Program Influence



Finally, the initial free-ridership score calculated above was then adjusted by a consistency check and a past participation adjustment score, if applicable (as shown in Figure 2-3). The free-ridership rate was then weighted by a measure and program level savings weight, and then divided by the weighted sum of the overall sampled kWh or CCF savings in order to determine the net free-ridership rate. The evaluation team determined the program's net free-ridership rate to be 12% for electric projects and 19% for gas projects. Results are shown at the end-use level in Table 3-6 and Table 3-7. The highest free-ridership score was for the electric controls end-use category. Most survey participants with a controls project end-use indicated some level of partial free-ridership, with a few survey participants indicating 100% free-ridership. This indicates that participants with controls projects are likely to install some degree of energy-efficient program measures in the absence of the program. It is possible that respondents were not aware of the specific differences in equipment given the technical nature of controls and further probing may have yielded different responses. However, consistency checks built into the survey corroborate the responses provided to the efficiency question.

The lowest free-ridership score end-use was the Other categories for both electric and natural gas end-uses. This is likely due to the end-uses' smaller population, sample size, and response rate.

Table 3-6. Free-Ridership Results by End-Use Category (Electric)

Sample Stratum	Electric Free-Ridership Savings* (kWh)	Electric Savings* (kWh)	Net Electric Free-Ridership
Controls	1,628,331	4,189,558	0.39
Cooling	1,568,817	12,990,339	0.12
Custom	1,098,134	4,869,255	0.23
Heating	231,079	1,680,580	0.14
Lighting	28,236,244	254,659,962	0.11
Motor	883,548	7,218,315	0.12
Other	0	347,231	0.00
Process	1,362,458	11,603,620	0.12
Refrigeration	1,517,548	12,125,419	0.13
Overall	36,526,159	309,684,279	12%

**These savings have been weighted using the methods described in Section 2.4 and Appendix F.*

Based on the evaluation team's review of past results, these estimates are in-line with both previous research in Connecticut and parallel research in Massachusetts. Controls and Custom projects tend to have higher levels of free-ridership given the complexity of their design and their cost. Based on these results, the evaluation team does not recommend any significant changes in program delivery. However, upcoming process and impact evaluations may want to assess standard practice for control systems and adjust baselines as necessary. However, controls still represent a relatively small portion of the EO program (approximately 1%) and as a result, does not present a significant risk to delivery.

Table 3-7. Free-Ridership Results by End-Use Category (Gas)

Sample Stratum	Gas Free-Ridership Savings (CCF)*	Gas Savings (CCF)*	Net Gas Free-Ridership
Controls	71,940	233,349	0.31
Custom	209,320	562,916	0.37
Heating / DHW	251,933	1,578,583	0.16
Other	0	49,097	*0.00
Process	214,893	1,588,438	0.14
Overall	748,086	4,012,383	19%

**These savings have been weighted using the methods and weights described in Section 2.4 and Appendix F.*

**Note that for the "other" category, all respondents reported high levels of program influence and were scored as non-free-riders.*

In order to weight our results, we created end-use level "measure weights" by using measure category savings in order to determine the weight that should be applied to each case. These weights, shown in detail in Appendix F, are calculated for a given end-use category by dividing the population of savings by the sampled savings. Measure weights were then applied to savings and the respective free-ridership and spillover scores in order to determine the net spillover and net free-ridership score, as shown in Equations 2-2 and 2-3 in Section 2.

Spillover Rate Results

After the free-ridership series, respondents were asked a series of questions to determine whether the program also influenced them to purchased additional energy efficient equipment outside of the program. These questions were used to estimate like and unlike-spillover.

To estimate like-spillover, respondents were first asked if they implemented any additional projects similar to what was installed through the program without a rebate from Eversource or United Illuminating. A little less than one third of respondents (29%) indicated they had installed similar equipment. Respondents who answered yes to the previous question were next asked if the equipment they installed on their own was the same efficiency level (or higher) as the equipment they installed in the program. Sixteen percent of survey respondents answered that the equipment they installed was the same high level of efficiency. These respondents were next asked to quantify the amount of additional equipment they installed as a percentage of the equipment they installed through the program. Respondents were also asked if they were influenced by a contractor or design professional to install additional equipment. If they answered yes, the evaluation team reduced their initial spillover rate by 50%. These responses were also subject to an overall consistency check to ensure that a respondent's spillover rate was in line with their responses throughout the survey. Like-spillover was then calculated as the measure-specific savings identified by the program multiplied by the quantity adjustment identified by the respondent in the like-spillover section of the survey.

Unlike-spillover was calculated in a manner similar to like-spillover. Respondents were first asked if they had installed or implemented any other type of energy-efficient equipment on their own, without a rebate from Eversource or United Illuminating. Respondents who answered yes (41%) were then asked if the equipment installed was eligible for an incentive through the program. Just 15% of respondents indicated affirmatively. In order to estimate unlike-spillover savings, these respondents were asked to estimate the quantity of each additional piece of equipment installed without program support. Of the 15% of respondents who indicated unlike-spillover, we were able to provide savings estimates for 50% of the additional equipment installed by respondents. The remaining half of respondents described equipment that did not match any of the end-uses, or did not know how many pieces of additional equipment they had installed.

To estimate savings for unlike spillover, we found the average savings for each end-use category. If a respondent reported installing an additional project that matched the end-uses in our study, we were able to estimate these savings by multiplying the average savings in that specific end-use category by the quantity of equipment they reported. If a customer reported an end-use not within the scope of this study, we were unable to provide estimates for unlike-spillover. These savings estimates were then weighted and divided by the overall sampled savings for the downstream program. Estimates for like and unlike-spillover are shown in Table 3-8 and Table 3-9.

Table 3-8. Like and Unlike-spillover by Program End-Use (Electric)

Sample Stratum	Electric Like-spillover Savings*	Electric Unlike-spillover Savings	Electric Savings*	Net Electric Like-spillover	Net Electric Unlike-spillover
Controls	481,489	115,786	4,189,558	0.11	0.03
Cooling	604,437	0	12,990,339	0.05	0.00
Custom	1,183	0	4,869,255	0.00	0.00
Heating	112,624	0	1,680,580	0.07	0.00
Lighting	12,923,004	663,156	254,659,962	0.05	0.00
Motor	86,935	171,972	7,218,315	0.01	0.02
Other	0	0	347,231	0.00	0.00
Process	4,105,884	0	11,603,620	0.35	0.00
Refrigeration	33,306	0	12,125,419	0.00	0.00
Overall	18,348,861	950,915	309,684,279.07	6%	0.3%

These savings have been weighted using the methods described in Section 2.4 and Appendix F.

Table 3-9. Like and Unlike-spillover by Program End-Use (Gas)

Sample Stratum	Gas Like-spillover Savings*	Gas Unlike-spillover Savings	Gas Savings*	Net Gas Like-spillover	Net Gas Unlike-spillover
Controls	4,975	0	233,349	0.02	0.00
Custom	10,807	0	562,916	0.02	0.00
Heating / DHW	26,178	0	1,578,583	0.02	0.00
Other	0	0	49,097	0.00	0.00
Process	197,474	65,250	1,588,438	0.12	0.04
Overall	239,435	65,250	4,012,383	6%	2%

These savings have been weighted using the methods described in Section 2.4 and Appendix F.

Estimated Net-to-Gross Ratios

Once the evaluation team estimated free-ridership, like-spillover, and unlike-spillover, we calculated NTG ratios at the end-use level using Equation 2-1. These estimates are presented in Table 3-10 and Table 3-10 below. The highest NTG ratios were estimated for the Process (electric) and Other (gas) end-use categories. The lowest NTG ratios were estimated for the Controls (electric) and Custom (gas) end-use categories.

Table 3-10. Estimated Net-to-Gross Ratios by Program End-Use (Electric)

Sample Stratum	Free-Ridership	Like-spillover	Unlike-spillover	NTG Ratio
Controls	0.39	0.11	0.03	75%
Cooling	0.12	0.05	0.00	93%
Custom	0.23	0.00	0.00	77%
Heating	0.14	0.07	0.00	93%
Lighting	0.11	0.05	0.00	94%
Motor	0.12	0.01	0.02	91%
Other	0.00	0.00	0.00	100%
Process	0.12	0.35	0.00	124%
Refrigeration	0.13	0.00	0.00	88%
Overall	0.12	0.06	0.003	94%

Table 3-11. Estimated Net-to-Gross Ratios by Program End-Use (Gas)

Sample Stratum	Free-Ridership Rate	Like-spillover	Unlike-spillover	NTG Ratio
Controls	0.31	0.02	0.00	71%
Custom	0.37	0.02	0.00	65%
Heating / DHW	0.16	0.02	0.00	86%
Other	0.00	0.00	0.00	100%
Process	0.14	0.12	0.04	102%
Overall	0.19	0.06	0.02	89%

3.2 Upstream Program Results

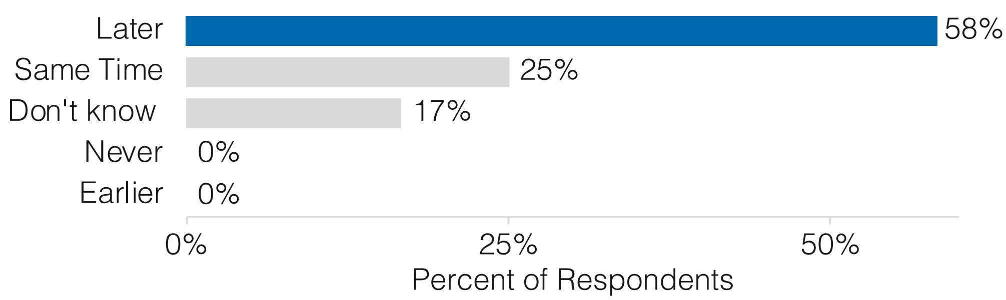
This section presents the estimated NTG ratios for upstream lighting projects with non-residential customers. This section discusses free-ridership scores, spillover scores, results from the distributor interviews, and provides an estimated NTG ratio. As discussed above, all estimates are based on screw-in purchases only and therefore results are not broken out by bulb type.

Free-Ridership Rate Results

Respondents were asked a series of questions regarding the timing, efficiency level, and quantity of LED purchases in the absence of the program to determine free-ridership. These three estimates were then used by the evaluation team to determine the program's net free-ridership rate.

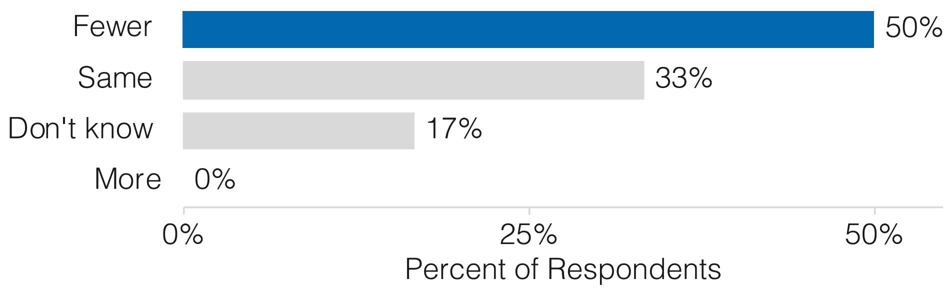
Respondents were first asked if they would have purchased LEDs at the same time without support from the program. If a respondent answered that they would not have purchased LEDs at the same time, they were asked to indicate if they would have purchased them at an earlier time, a later time, or never. The results, shown below in Figure 3-3, suggest that 58% of respondents would have purchased the bulbs at a later time without program support. Just a quarter of respondents would have purchased the bulbs at the same time without the program, and 17% of respondents reported that they didn't know when they would have purchased the bulbs without program support. No respondents reported they would never have purchased the LEDs without the program or that they would have purchased LEDs earlier without program support. On average, the 58% of respondents who stated they would have purchased their LEDs later would have done so 24 months later (the median response).

Figure 3-3. Timing of Decision to Purchase LEDs Without Program Support



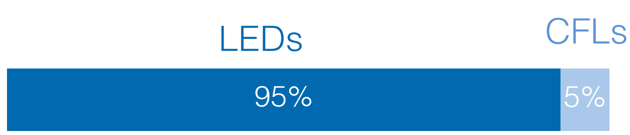
Survey respondents were next asked to report how the quantity of LED bulbs they purchased would have been impacted without program support. As shown in Figure 3-4 below, half of respondents (50%) reported that they would have installed fewer LEDs without the program. One third of respondents (33%) reported that they would have installed the same number of LEDs without the program, and 17% of respondents reported they were unsure how many LEDs they would have installed in the absence of the program. The average reduction in LED purchases reported by respondents who said they would have purchased fewer LEDs without the program was 40%.

Figure 3-4. Quantity of LEDs Purchased Without Program Support



Following the timing and efficiency series of questions, respondents were asked how the efficiency level of the equipment they purchased would have been impacted in the absence of the program. Respondents who previously indicated they would have purchased at least some of the LEDs on their own without the price discount were asked how their expected purchases would have been allocated between 1) LEDs, 2) lower efficiency, but above code bulbs and 3) standard efficiency, at code bulbs. The evaluation team advised respondents that these levels were equal to 1) LEDs, 2) CFLs, and 3) incandescent or halogen lamps. As shown in Figure 3-5 below, the vast majority of respondents (95%) suggested that they would have still installed LEDs, even without program support. Just one respondent reported that they would have installed CFLs (5% of overall responses), and no one reported that they would have installed halogens or incandescent bulbs.

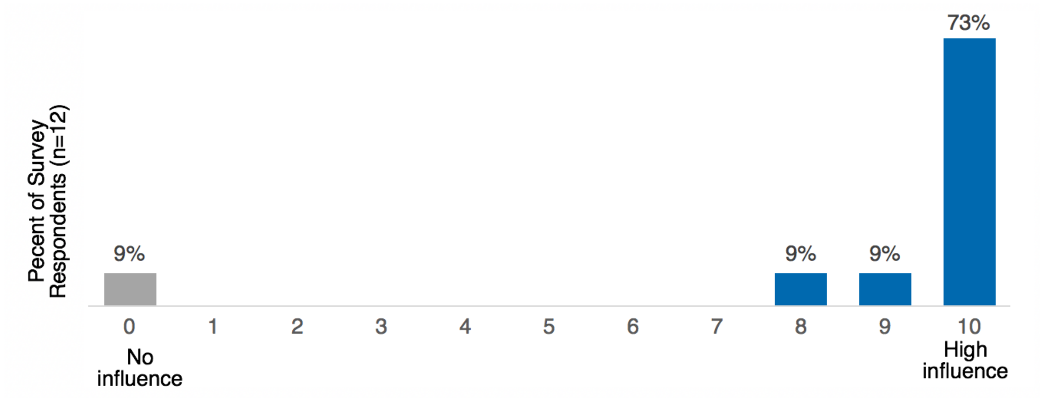
Figure 3-5. Efficiency of Equipment Without Program Support



Multiplying survey respondents' timing, efficiency, and quantity scores yielded the raw free-ridership estimate. The free-ridership raw score was then subject to an overall consistency check to ensure a survey respondent's answers aligned with their estimated free-ridership score. Finally, the free-ridership score was weighted by savings and then divided by the upstream lighting program's overall kWh savings. The specific weight and weighting methodology is described in more detail in Appendix F. The evaluation team determined the program's net free-ridership rate to be 40%.

In addition to estimating timing, quantity, and efficiency level of bulbs purchased in the absence of the program, the evaluation team also asked respondents about the degree of influence the program had on their decision to purchase LEDs. This score was used as a benchmark against participant's raw free-ridership scores. According to Figure 3-6 below, 91% of survey respondents rated the influence of the rebate on their decision to install LEDs as an 8 or higher on a 1-to-10 scale. This suggests that respondents highly value the rebate and believe the rebate had a great deal of influence over their decision to purchase LEDs in contrast to their responses on the efficiency question which indicated they would have installed mostly LEDs without program support.

Figure 3-6. Influence of Rebate on Decision to Purchase LEDs



Spillover Rate Results

Following the free-ridership series of questions, respondents were asked about whether the program had also influenced them to purchase additional LED products outside of the program. The survey suggests that at least one third of respondents (33%) purchased additional LEDs outside the program.

Respondents were also asked if they were influenced by a contractor or design professional to purchase additional LEDs. If they answered yes, the evaluation team reduced their initial spillover rate to 50%. Additionally, if the respondent reported the reason they did not apply for the rebate was because they believed their purchased equipment would not qualify, their score was further reduced by another 50%. These responses were also subject to an overall consistency check to ensure that a respondent's spillover rate was in line with their responses throughout the survey. To quantify the amount of spillover savings, surveyors also asked respondents how many additional LEDs they purchased out of the program. These quantities were then multiplied by the average screw-in LED savings. The evaluation team determined the average screw-in LED savings to be approximately 135 kWh by dividing total number of screw-in LED kWh savings by the total quantity of screw-in LEDs purchased. The savings were then weighted by a measure- and program-level savings weight to determine the amount of spillover savings associated with the program. Finally, the spillover savings were divided by the overall sampled upstream program-level savings. The evaluation team estimated the upstream program's net spillover rate to be 23%.

Supporting Results from Interviews with Distributors

Interviews conducted with LED lighting distributors largely bolstered the free-ridership and spillover estimates presented above. Regarding free-ridership, three out of four lighting distributors stated that the program incentive was largely beneficial to their customers and that, in the absence of the incentive, they would anticipate selling some LEDs without the program but at lower levels. Two distributors noted:

- "Screw-ins are definitely more expensive than the incandescents. I don't know that we could persuade a customer to buy it [in the absence of the program]. It'd be hard to make up that $8 difference without the rebates."
- "The program is affordable for end-users and benefits them very much so."

With regards to spillover, distributors were asked to estimate the percentage of LED sales in 2017 that were not buydown or discount bulbs but influenced by the program. Three of the four interviewees were able to provide estimates, shown in Table 3-12 below.

Table 3-12. Distributor Estimated Percentage of Non-Program Bulbs, 2017

Interviewee	Bulb Type	Estimate
1	0.75	0.25
3	0.6	0.40
4	0.3	0.20
Average	0.55	0.28

The distributors were also asked why they did not receive the buy-down or discount for the estimates provided above. Two distributors noted that the bulbs were energy efficient but did not meet the specific requirements to qualify for the program. The remaining two distributors noted:

- "It's not just the paperwork but explaining it to somebody and having all the higher-ups understand. Smaller projects are not worth that effort; they don't have a salesman that does just that."
- "Some contractors don't have the time for it—they won't be bothered with it."

Estimated Net-to-Gross Ratio

The evaluation team then used the net free-ridership rate and net spillover rate to estimate a NTG ratio for the upstream lighting program using Equation 2-1 above. No unlike-spillover was estimated for the upstream program. Table 3-13 below present the net free-ridership, spillover, and NTG ratio.

Table 3-13. Upstream Screw-based Lighting Program NTG Results (Eversource Only)

Program	Estimated Free-rider Savings	Estimated Spillover Savings	Total Sampled Program Savings	Net Free-Ridership Rate	Net Spillover Rate	NTG Ratio
Upstream Lighting	64,345.12	39,526.60	159,434.40	0.40	0.23	83%

Note that the evaluation team's research did not include any linear lighting. As shown in Table 3-14, a majority of the claimed upstream LED savings were for screw-in lamps. We concentrated our limited number of interviews on customers who installed those lamp types, but acknowledge that in the future, linear LEDs will likely make up a larger percent of upstream program activity and that our estimate for upstream program influence may not be applicable. However, Massachusetts recently studied the NTG ratio of linear LEDs their most recent study. The NTG values they determined for linear and screw in LEDs from their most recent studies include:

- Screw-based: 73%, 63%, and 53% prospectively in 2019, 2020, and 2021 respectively
- Linear: 80%, 73%, and 66% prospectively in 2019, 2020, and 2021 respectively

Based on these results, the NTG for linear bulbs should be approximately 9.6% higher than that of screw-based bulbs (the relative increase in NTG between the types of equipment or (.80/.73) - 1). In addition, program attribution for screw-based bulbs should decrease by 10% (absolute) each year and by 7% (absolute) each year for linear fixtures. As a result, we recommend applying a NTG of 91% to linear bulbs in the 2020 Connecticut PSD. Absent further research, we recommend that the 2021 and 2022 PSD reflect a similar decrement as found in Massachusetts. These values are shown in Table 3-15 below.

Table 3-14. Upstream Lighting by Product Type

Product	Number Sold	kWh Savings	Percentage kWh of Total
LED Fixtures	389	69,229	3%
A-Lines	5,851	931,651	38%
Decorative	165	13,051	1%
G24 LED	3,342	187,152	8%
LED Downlights	567	86,467	3%
MR16	522	47,609	2%
PAR20, PAR30, PAR38	7,537	1,136,310	46%
Stairwell Kit, Low-Output w/sensor	80	12,094	0%
Total	**18,453**	**2,483,565**	**100%**

Table 3-15. Forward-Looking Upstream Lighting NTG Estimates

Product	2020 NTGR	2021 NTGR	2022 NTGR
Screw-based LEDs	83%	73%	63%
Linear LEDs	91%	84%	77%

3.3 Energy Opportunities NTG Scores Comparison

The evaluation team compared the results from this study to the EO program NTG ratio estimates from 2011. Table 3-16 presents these results in detail. As indicated in the table, the overall program rates are nearly identical for electric component of the program and decrease by 12% for the gas program from 2011 to 2017. For electric end-uses, when viewed at the end-use level, these rates for the most part differ only slightly. Notable differences between the 2011 and 2017 NTG estimates include the electric Process category, which increased 27% (from 97% to 124%) and the electric Controls category, which decreased 25% from (100% to 75%).

For natural gas measures, this decrease in the overall natural gas NTG estimate is primarily due to an inclusion of an outlier spillover project identified in the 2011 study that was not replicated in 2017. In 2011, one project was identified that included a 100% spillover estimate, skewing overall project results. The table also compares Connecticut results with recent Massachusetts results.

Table 3-16. Energy Opportunities NTG ratios Comparisons, Connecticut (2011, 2017) and Massachusetts (2013, 2018)

End-Use	Fuel Type	2011 CT NTG Ratio	2017 CT NTG Ratio	Change	2015 C&I MA NTG Ratios
Controls	Electric	100%	75%	-25%	N/A
Cooling	Electric	80%	93%	-13%	88%
Custom	Electric	76%	77%	+1%	101%
Heating	Electric	85%	93%	+8%	88%
Lighting	Electric	96%	94%	-2%	97%
Motor	Electric	N/A	91%	N/A	113%
Other	Electric	97%	100%	+3%	N/A
Process	Electric	97%	124%	+27%	96%
Refrigeration	Electric	97%	88%	-9%	90%
Upstream Lighting (Screw-based Only)	Electric	N/A	83%	N/A	82%[17]
Overall Electric		93%	94%	+1%	96%
					2018 C&I MA NTG Ratios
Controls	Gas	69%	71%	+2%	N/A
Custom	Gas	N/A	65%	N/A	86%
Heating / DHW	Gas	83%	86%	+3%	83% / 89%[18]
Other	Gas	N/A	100%	N/A	81%
Process	Gas	189%	102%	-87%	89%
Overall Gas		101%	89%	-12%	84%

Note; The evaluation team added added Custom, Heating and Domestic Hot Water, and Other categories for Gas. We combined HVAC and Domestic Hot Water as part of the sample design. These adjustments were based on the frequency of measures in the data and aimed at providing greater nuance in net-to-gross estimates.

[17] From the evaluation of 2012 Bright Opportunities evaluation in Massachusetts.
[18] The 2018 Massachusetts Study assessed Heating and DHW separately.

EMI CONSULTING

4. RECOMMENDATIONS

As part of the Energy Opportunities NTG study, the evaluation team analyzed key drivers of the program's NTG estimates and identified ways to increase NTG in the future. These key drivers and their respective recommendations are presented below. In addition, we have provided several recommendations on how to improve future NTG studies in Connecticut, based on our experiences with this research effort.

1. The evaluation team found relatively stable NTG ratios for the EO program when compared to both the past research in Connecticut and recent research in Massachusetts. While our research did not include NPSO estimates, past research in Connecticut also did not identify any NPSO savings for the EO program.

    - Recommendation 1: Update the 2020 PSD with the NTG values found in this study. This includes adding a separate NTG value for electric Controls and applying the program-level natural gas results to all natural gas measures (as was done in 2011). By applying NTG values at the program level for natural gas measures, it mitigates the impact of outliers present in the small sample size. This includes a NTG value of 83% for screw-based LEDs and 91% for linear LEDs as part of the Upstream Lighting program component.[19]

    - Recommendation 2: For the 2021 and 2022 Upstream Lighting program, apply prospective NTG based on expected changes in the lighting market. Based on this study and studies in Massachusetts, the evaluation team recommends a NTG value of 73% for screw-based LEDs and 84% for linear LEDs in 2021. Similarly, we recommend that the PSD include a NTG value of 63% for screw-based LEDs and 77% for linear LEDs in 2022.

2. The EO program is accelerating adoption of energy-efficient equipment and increasing the scope of projects. Most participants indicated that they likely would have installed some energy-efficient equipment without the program, but at a later date or in a smaller quantify and were greatly influenced by previous participation.

    - Recommendation 3: **Leverage upcoming process evaluations to further explore effective channels for accelerating equipment adoption (focusing on lighting and refrigeration based on survey responses regarding project timing).** While this study identified that the EO program is accelerating adoption, we recommend that upcoming process evaluation studies examine what specific channels are most effective at influence customers.

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[19] Note that this value is based on secondary research from parallel studies in Massachusetts as the end-users who participated in the sample did not purchase any linear lighting fixtures, they were only asked questions regarding their screw-in bulb purchases.

3. Previous program participation adjustment scores had a noticeable positive impact on the program's free-ridership rate. In the downstream survey, participants were asked a series of four questions to gauge the effect past program participation had on their decision-making process. Based on the number of questions a respondent answered affirmatively, their free-ridership rate was reduced 75%, 37.5%, or not at all. These reductions were made to account for the effect positive program experiences had on participants' decisions to install or implement energy-efficient equipment through the program. On average, 53% of the electric projects and 59% of the gas projects were influenced by past participation in the EO program, increasing their overall NTG ratio. This demonstrates that previous program participation has a large influence over future program participation and that customers are likely to be repeat program participants after their initial participation and may not have participated had they not had previous positive experience with the program.

    - Recommendation 4: Leverage relationships with past program participants to encourage future program participation. Program participants indicated in the survey that they see utility program staff as a trusted resource for unbiased information, including on key financial decision-making factors. Program staff should continue to follow-up with past program participants and encourage them to find opportunities to upgrade or install energy-efficient equipment through the program. In addition, these relationships with repeat participants should be explored in upcoming process evaluations.

4. The majority of program participants (61%) learned about the program through a third party, such as their contractor, a co-worker, or a design professional.

    - Recommendation 5: Continue to market to target trade partners, and increase marketing tactics specifically towards potential program participants as it seems that is not the way most participants found out about the program. While the program appears to be successful marketing to third party contractors, vendors, or design professionals, program staff should increase marketing to program participants to increase program awareness. Channel awareness should be considered as an evaluation objective for upcoming process evaluations.

5. The evaluation team experienced difficulties completing the interview targets established in the original sample plan. The evaluation team attributes these difficulties to two primary factors: (1) the lag between project completion and the survey and (2) the end-use breakdown. Some participants were interviewed up to 18 months after their project was completed. This lag (combined with missing contact information) made identifying the decision-maker difficult and may have also introduced error associated with the participants' recall of the decision. In general, the further a study is conducted from the decision-point, the less likely the respondent will be able to accurately recall all of the point of influence from the EO program. In addition, the focus on specific end-uses in our design created a complicated sample plan, because many end-uses have very small populations (fewer than 20 participants).

- Recommendation 6: Implement rolling surveys and an aggregated sampling plan. To improve overall participant response, the evaluation team recommends two options. First, we recommend that the EEB consider a "rolling" NTG assessment in which participants provide self-report responses on a more frequent basis. This would improve overall response count and decrease recall bias associated with the self-reported program influence. Second, we recommend exploring whether it may be more appropriate to focus on delivery method, including downstream prescriptive, downstream custom, and upstream models as the program delivery model may be the key NTG ratio determinant not the end-use. This aggregation may allow for larger populations from which to establish representative sampling frames.

- Recommendation 7: Collect end-user data for all upstream program participants. To improve overall data collection, the evaluation team recommends collecting customer contact information for upstream program participants if the design remains point-of-sale. If buy-downs move further upstream, consider requiring sales data from distributors or manufacturers to conduct a market-based analysis of impact on lighting sales.

- Recommendation 8: Improve end-user contact information for all participants. Based on the evaluation team's review of the contact data, some participants had either 1-800 lines or fabricated telephone numbers (e.g., (123) 456-7890) as their contact information. This type of contact information inhibits our ability to reach project contacts and threatens the validity of these estimates. We recommend that PAs conduct periodic QA/QC reviews of these contact fields to ensure that quality information is being collected. In response to this report, both PAs confirm that the amount of end-user data collected through distributors has increased.